NATURE

No. 4123 SATURDAY, NOVEMBER 6, 1948 Vol. 162

CONTENTS

	Page
Scientific Research and Man-power	711
Anti-Cancer Drugs. By Dr. I. Hieger	713
Testing Petroleum Hydrocarbons. By H. B. Milner	714
Chemistry of Acetylene. By R. A. Raphael	715
The Anodizing of Aluminium. By H. W. L. Phillips	715
Taxonomy and Evolution of Cotton. By E. Lord	716
Movements of Population in the British Commonwealth. By Prof. Brinley Thomas	718
Physical Chemistry of Process Metallurgy. By Dr. F. D. Richardson	719
Veterinary Education : Developments at Cambridge. By Dr. James T. Edwards	721
Obituaries :	
Prof. Ruth Benedict. By Dr. Audrey I. Richards	725
Sir George Hill, K.C.B. By Sir John Myres, O.B.E., F.S.A.	725
Mr. O. H. Latter. By J. C. Thomson	726
News and Views	726
Letters to the Editors :	
Life-Span of Red and White Blood Corpuscles of the Hen.—J. Ottesen	730
Introduction of Radioactive Tracers into Antisera.—F. D. S. Butement	731
Succinic Acid in the Blood of the Larva of *Gastrophilus intestinalis*.—L. Levenbook and Dr. Y. L. Yang	731
Staphylococcal Coagulation and Fibrinolysis.—Earl B. Gerheim	732
Excretion of α-Pyrrolidone Carboxylic Acid by Rat and Dog Fed with Tumour Proteins.—Prof. F. Kögl, T. J. Barendregt and A. J. Klein	732
Bacteriostatic Action of Oximes.—J. D. Allan Gray and R. A. Lambert	733
Aluminium Phosphate as Precipitant of Agglutinable and Non-Agglutinable Strains of *H. pertussis*.—Dr. J. Ungar and P. Muggleton	734
N. Acridyl-(5)-Alanines as Antibacterial Substances.—Prof. W. H. Linnell and M. J. H. Smith	735
Genetic Transmission of Two Rare Blood-Group Genes.—Dr. A. S. Wiener	735
Methylene Blue as a Vital Stain for the Golgi Apparatus.—Prof. J. Brontë Gatenby and Tohamy A. A. Moussa	736
Passage of Hæmoglobin from Blood into Eggs of *Daphnia*.—Elisabeth I. B. Dresel	736
Effect of Carbon Dioxide on Availability of Manganese in Soil Producing Manganese Deficiency.—B. D. Bolas and G. B. Portsmouth	737
Protection of Grain against Weevils.—V. A. Beckley	737
Fast Neutron–Proton Scattering and the Law of Interaction between Nucleons.—E. H. S. Burhop and H. N. Yadav	738
Photo-Elastic Effect in Barium Nitrate.—Prof. S. Bhagavantam and D. Suryanarayana	740
Inclusions in Aluminium Crystals.—W. May, T. J. Tiedema and Prof. W. G. Burgers	740
Electrokinetic Potentials of Aged Barium Sulphate Crystals.—Prof. R. Ruyssen and R. Loos	741
Factors Controlling the Atlantic Coastline of Europe.—Muriel A. Arber	741
'Pins and Needles'.—G. Gordon	742
Persistence of D.D.T. in the Soil.—Phillip B. Carne	743
Entomological Aspects of 'Swollen Shoot' of Cacao.—F. A. Squire	743
International Union of Geodesy and Geophysics. By Prof. J. Proudman, F.R.S.	744
Order of Stability of Metal Complexes. By Dr. H. Irving and R. J. P. Williams	746
First International Congress on Rheology. By Dr. G. W. Scott Blair	747
National Research Council of Canada : Annual Report	748

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London

Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

All rights reserved. Registered as a Newspaper at the General Post Office

SCIENTIFIC RESEARCH AND MAN-POWER

THE address which Mr. Herbert Morrison, the Lord President of the Council, delivered to the Conference of Industrial Research Associations on October 15 (see *Nature*, October 23, p. 645) should be studied carefully by all who are concerned with the conduct of scientific research and, in this time of stringently limited man-power, with the most effective distribution of the available scientific man-power between industry, the universities and the Government services in Britain. The development of the industrial research associations, with which the Lord President was ostensibly concerned, cannot wisely be considered apart from the general research effort of the country. As the recent report of the Advisory Council on Scientific Policy indicated, approximately ten per cent of the qualified scientific workers engaged in Great Britain's research effort are already employed by the research associations. At the present time, any appreciable increase in their numbers must be at the expense of those employed in research in industry, in the universities or in other Government departments.

Mr. Morrison, in referring to the Government policy of encouraging the establishment of research associations and the assurance given three years ago that Government support would not be withdrawn after an initial stage, said that the Government had been very much impressed by the results being obtained by some of the research associations. Last year, their total expenditure was close on £2 millions, as against £470,000 in 1938, and the total estimated for next year is £2·5 millions. Even allowing for the general rise in costs, the effort has more than doubled, and there are now thirty-eight research associations as against twenty-one in 1938 ; while the formation of others is expected in the near future. He hoped that the Conference would lead to even bigger developments.

Through all the examples of the work of the research associations which Mr. Morrison cited as having particularly impressed the Government runs the thread of increased productivity, or the increase of industrial efficiency by the saving of fuel and of labour. The Lord President seems to regard the research associations primarily as valuable contributors to the increased industrial productivity by which alone Great Britain can hold its place in competitive world industry. Further, his speech indicates approval for greater encouragement of the study of man in relation to the machines he has to operate—a matter in which, as Sir Henry Tizard pointed out in his presidential address at Brighton to the British Association, industry has lagged far behind the Services. It might, indeed, be inferred from his speech and from the increased attention being given by the research associations to what is known as 'operational research', as judged by examples recently quoted, that an increasing proportion of their effort will be directed to the study of the human aspects of production and economic and

sociological problems, as distinct from those physical problems to which their original effort was almost exclusively devoted.

It is not disputed that the particular technique developed in war-time under the name of 'operational research' and long since employed in progressive industry in its technical service to customers may have large potentialities. Both the need and the opportunity for such methods might possibly diminish, however, if we could secure the more effective utilization by industry—and by the State—of existing knowledge. Mr. Morrison frankly recognized that a large part of the problem of increasing productivity and industrial efficiency lies in securing the utilization of the results of past research as well as of that at present proceeding, and he indicated the readiness of the Government to use whatever resources are at its disposal to see that proved processes and equipment developed by the research associations should not be left unutilized.

Nevertheless, although the Lord President stressed the importance of those engaged in research having full opportunity to know what are the problems of industry, and above all, the needs of users and consumers of industrial products—and, indeed, asked whether the opportunities in the research association movement for co-operation between all engaged in industry are being fully taken—he did not stay to discuss the fundamental question whether that was or was not due to any inherent defect in the research association idea itself. He did inquire whether there is enough in industry of the approach and interchange which characterized the development of equipment for the Armed Forces, and he also asked whether there are enough scientific workers employed in industry helping to get the best of the scientific results which are already available. He also dwelt at some length on the importance of scientific interpreters and liaison officers, and of encouraging, in every way possible, contacts and exchange of visits between scientific men and industry.

There is, indeed, a large field for co-operative effort where the research association, as Mr. Morrison indicated, may pay handsome dividends in terms of productivity and the saving of materials and labour. It is by no means established, however, that the research associations can compare with the research departments of industrial firms in the development of those new products and processes which place British industry ahead and not just abreast of its rivals in the world markets, and which, as Sir Henry Tizard reminded us, are the product of the work of very few men.

What needs to be considered much more closely is how best that spirit of enterprise and inventiveness can be fostered. Mr. Morrison touched on many important factors and indicated some of the means by which industry in Great Britain could recover some of the ground lost in the development stage to such countries as the United States. He said little, however, to show that he appreciated the importance of the really fundamental research in which Britain excels, and on which in the long run industrial advance is based.

Some of that work is being carried out by the research associations, and some of it in the laboratories of leading industrial firms. By far the greater part of it, however, is proceeding in the university laboratories; and the questions that have to be faced, before and not after any considerable expansion of the research associations, are: first, will such expansion affect adversely the fundamental research at the universities, now seeking to make up for the lost years of war? And secondly, will such expansion yield higher dividends in creative work as well as productivity than a corresponding expansion of industrial research laboratories themselves, or if not, then some alternative form of co-operative research, such as the Mellon Institute type? In the present man-power situation we cannot expand all three types indefinitely; we must attempt to establish some order of priority based on an impartial critical survey.

In this speech, for all the appreciation of the value of scientific research which it shows, Mr. Morrison passes over the seriousness of the man-power situation. Research workers, he said, must have the resources and status they need to keep up the flow of new and improved products, and he welcomed the improvement in the status and conditions of British scientific workers. He also stated that the Government has now decided that a larger share of building resources must be made available for the equipment of research and other institutions likely to contribute to raising the productivity of industry.

That will be welcome news to some firms, whose plans for expansion and development have been restricted by lack of such facilities, and by the policy laid down in the White Paper last spring. It must be remembered, however, that the major difficulty experienced by the larger and the smaller firms alike is the recruitment of first-class men for research and development; and particularly from the university schools of chemistry. If in consequence some firms who have recently been imbued with the research spirit are driven to recruiting men of inadequate standing for their new research departments, the new enthusiasm of those firms is likely to be damped, and still more as the results may well fall short of expectation.

Such factors may well lie outside the field of such a conference as that addressed by Mr. Morrison, but they should not be overlooked by one who carries so large a share of responsibility for determining the distribution of the scientific effort of Britain at a time when expansion in any one direction of necessity involves curtailment elsewhere. Nor can he well afford to disregard those factors which, like conditions of service, may influence as profoundly as Government policy the distribution of scientific workers in particular occupations. Quite apart from the distribution of, say, the available chemists, biochemists and physicists between industry, academic research, the research associations and Government departments, has any real thought been given, from the national point of view, to the effect of unbalanced expansion of university departments of medicine in comparison with their other scientific departments,

or of the wide disparity in the inducements offered to the graduate in medicine as compared with those received by the chemist, biochemist or physicist ?

It is true that industry itself might well do something to redress that balance by the evolution of financial incentives, possibly of the invention-bonus type; but those responsible for the scientific and industrial policy of the Government can no more ignore such considerations in determining the future of the research associations than they can the effect on the universities themselves of the conflicting and unco-ordinated pressures for expansion, on which the recent statement from Nuffield College on "The Problem facing British Universities" commented so pointedly. Dr. C. J. T. Cronshaw's remarks on this subject to the Society of Dyers and Colourists in Bradford on October 7 should be noted in this connexion, as should those of Sir Ian Heilbron at the annual dinner of the Association of British Chemical Manufacturers on October 13.

A short-term policy which concentrates on securing the more effective utilization of existing knowledge may, as Sir Henry Tizard suggested in his presidential address to the British Association, be our immediate need from the point of view of increasing productivity and restoring the industrial health of Great Britain. In that policy the research associations have clearly a part to play, and the policy will simultaneously encourage the continuous application of science to industrial practice. That, however, does not mean putting research into the second place; and such a short-term policy must not be pursued at the expense of a long-term policy designed to ensure the nation a sufficient supply of scientific men and technologists in every sphere and to provide them with the equipment and resources they require. A long-term policy of that type can only be evolved as a result of the open-minded study of the effectiveness of particular instruments for our purpose, such as the research associations, in comparison with other methods. A resolute attempt must be made to decide where and how creativeness and inventiveness are best fostered, and an impartial and continuing appraisal made of the demands of industry, the universities and the Government services, and the interactions of those demands.

To achieve a reasonable balance is no easy task, but no more urgent task awaits the Advisory Council on Scientific Policy than such a fundamental and comparative inquiry into the research association movement in relation to other forms of co-operative and industrial research. Sir Henry Tizard, it would appear from his presidential address to the British Association, is ready to make that attempt; the Lord President of the Council might well support such a task, for no other way seems so likely to establish the best means by which during the next few critical years our limited resources in scientific man-power and equipment may be deployed so as to yield the quickest and largest return in productivity and in new and improved products. The inquiry would not be an easy one; and the evolution of a policy on the basis of its results could be undertaken only at the highest levels.

ANTI-CANCER DRUGS

Approaches to Tumor Chemotherapy

A symposium of Papers and Discussions on various Aspects of Tumor Chemotherapy, developed from the Summer Meetings of the Section on Chemistry (C) of the American Association for the Advancement of Science at Gibson Island, Maryland, 1945–1946. Edited by Forest Ray Moulton. Pp. x + 442. (Washington, D.C.: American Association for the Advancement of Science, 1947.) n.p.

THE historical introduction to this series of papers is by the *doyen* of American cancer research, W. H. Woglom, who with brilliant lucidity and charming modesty of style describes the use of the innumerable agents of mineral, plant, animal or synthetic origin which have figured in the untiring attack on malignant disease by chemotherapy. He believes that hormone therapy has given the first hopes of ultimate success.

Algire discusses the method that he has developed of introducing a transparent chamber into a skin flap of the mouse, enabling the vascularization of transplanted tumours, or the regression of a tumour undergoing treatment with bacterial polysaccharide, to be observed. No doubt the method is a triumph of technique; but the photomicrographs are not very informative to the uninitiated and there is nothing startling about the discovery that the blood vessels rapidly develop to cope with the new growth; further, is it really necessary, to-day, to introduce an illustration of a photomicrographic camera ?

Kopac's article is on "Cellular and Surface Chemical Aspects of Tumor Chemotherapy"; it is no easy task to find one's way through the thirty pages of complicated laboratory data and question-begging hypotheses. His thesis seems to be that one group of chemotherapeutic agents acts by selective nucleoprotein dissociation. Although there are references to selective destruction of neoplastic cells *in vitro* by these compounds, no mention is made of the results of tests *in vivo*. It is to be feared that some hiatus was discovered between physico-chemical hypothesis and biological facts.

Aptekman uses an alcoholic extract of transplantable rat tumour to destroy grafted tumours in other rats; but his extract contained about 20 per cent alcohol which alone, apart from tissue constituents, could scarcely have been encouraging for the growth of the tumour.

Turner and Miller's paper on "The Chemistry of Substances Specific for the Stimulation of Lymphopoiesis and Myelopoiesis" describes the investigation of agents present in the urine of patients with myeloid leukæmia which produce myeloid metaplasia in the organs of experimental animals. Heinle, Hirschmann and Wearn also write on the myeloid metaplasia factor in human urine; but their work is obviously unfinished, for they state: "This issue obviously is not decided by the fact that the protein fractions prepared from various urines show great differences in biological activity. These observations, however, could suggest that the active principle in these fractions may possess the degree of structural specificity that one expects to find in a regulatory hormone." These two papers deal largely with the biochemistry of the substances from urine which influence the myeloid tissue; on the other hand, the discussion which followed the papers centred around the interpretation of the pathological changes in the injected animals.

Tannenbaum, in his paper "Role of Nutrition in the Origin and Growth of Tumors", puts forward the evidence for his thesis that, in mice, a 60 per cent calorific restriction inhibits the development and reduces the incidence of spontaneous mammary cancer, and also retards the formation of induced skin, subcutaneous and lung tumours by hydrocarbons. Such experimental results are supported by statistical data from insurance companies which indicate that overweight human subjects are particularly liable to cancer.

Opie, in "Influence of Diet on the Production of Hepatic Tumors induced by *p*-Dimethylaminoazobenzene", states that a rice diet facilitates tumour formation, and that kidney and liver in the diet inhibit it, as do also riboflavin and nicotinic acid. A low-protein or high-fat diet was favourable to tumour production, whereas a high-protein or low-fat diet effected some retardation. Diets that protect against cirrhosis also protect against neoplasia; but tumours can arise in the absence of cirrhotic changes.

A group of papers by Lewisohn, Laszlo, and C. and R. Lenchtenberger, taking up, with discussion, sixty-eight pages, on "Chemotherapeutic Regressions of Transplanted and Spontaneous Cancers in Mice", deals with the use of the *L. casei* factor (folic acid) as inhibitor. Their results are severely criticized in papers by Sugiura and by Zahl and Hunter, who find no convincing evidence that this substance does, in fact, inhibit tumour growth.

A historical account is given by two descendants of William B. Coley of his treatment of malignancy by bacterial toxins. There follows a series of papers (45 pages) by a large group headed by Shear, bearing the resounding title of "Some Aspects of a Joint Institutional Research Program on Chemotherapy of Cancer: Current Laboratory and Clinical Experiments with Bacterial Polysaccharides and with Synthetic Organic Compounds". Unfortunately, this monument of organisation and industry has not as yet yielded chemotherapeutic results of proportional significance. One is tempted to ask whether it is really necessary to reproduce a photograph of a small bottle, bearing the legend, "Sterile solution of polysaccharide prepared for clinical use. Sterile cotton plugged needle, inserted through the outer region of the rubber stopper, extends into the bottle."

More than a hundred pages are devoted to a number of papers on nitrogen mustards (chloro-ethyl-amines) for the treatment of lymphomas, leukæmia and allied conditions. The energy expended in these investigations and in the preparation for publication must have been immense; nevertheless, the opinion has been expressed by some authorities that the mustards are not superior to X-rays in the treatment of these types of malignancy.

Huggins, in an admirable paper of four and a half pages, describes the "Antiandrogenic Treatment of Prostatic Carcinoma in Man"; more space might have been given to an account of this valuable contribution to tumour chemotherapy. Reinhard and Womach describe the application of radioactive phosphorus to the treatment of leukæmia, Hodgkin's disease and polycythæmia, of which only polycythæmia is benefited by this agent.

The two papers by British investigators, Haddow and co-workers, and Parry and Innes, dealing with the use of urethane in the treatment of lymphatic and myeloid leukæmia, lead to the conclusion that the drug certainly has a temporary ameliorative effect on the disease; but unfortunately the improvement is not maintained.

Engelbreth-Holm and Stamer's paper is on the somewhat heroic treatment of leukæmia with the most powerful carcinogen (9 : 10-dimethyl-1 : 2-benzanthracene); one of the patients was still alive eighteen months after treatment.

Geschickter and Reid contribute an account of the use of oil-soluble organo-metallic compounds in malignancy; iron, cobalt, copper, manganese and nickel were given in the form of fatty-acid–phthalate derivatives. Leukæmias responded favourably to these substances, as they do indeed to other drugs and radiations.

Much of this book, or rather collection of papers, makes tedious reading, for a large part consists of detailed technicalities somewhat distantly related to the aim expressed in the title. It is doubtful if the verbose accounts of laboratory or clinical findings will interest any but the pure specialists, which may help to explain why the verbatim reports of the discussions which followed the papers are nearly always more interesting than the papers themselves.

I. HIEGER

TESTING PETROLEUM HYDROCARBONS

Standard Methods for Testing Petroleum and its Products

Ninth edition. Pp. xlviii + 616. (London: Institute of Petroleum, 1948.) 31*s*.

THE first edition of "Standard Methods" appeared in 1924, initially at the instigation of Sir Boverton Redwood and following labours of the pioneer committee under Prof. Brame. During the ensuing twenty-four years the volume has steadily grown in stature and authority; once again, in this ninth edition we recognize a mandate for laboratory procedure which for long past has commanded international respect. As is the case with preparation of other 'standards', whether governing quality of materials or guiding methods by which that quality is assessed, few realize the enormous amount of work put in voluntarily by specialists representing every possible angle of the subject concerned. Standardization committees are notoriously time-consuming bodies, and this particular case has clearly been no exception; apart from the main committee, no less than sixty-two sub-committees, panels and working groups, involving some two hundred and seventy experts, contributed to this considerable task, and it may be said at once that it has been worthily discharged.

Naturally the technician familiar with previous issues of this volume will want to know wherein it differs from its predecessors. Only two methods have been withdrawn, namely, acetate content of solvents and halogen content in lubricating oil. The new methods comprise determination of chlorine in lubricating oil, knock-rating of aviation fuels (rich mixture), lead, copper and iron in lubricating oils, oil separation on storage of grease and spectrographic analysis of inorganic constituents of ashes; this last is a welcome inclusion of a technique now so freely employed in inorganic analysis.

Revision of existing methods affects the corrosion test for lubricating greases, diluent content of crankcase oils (Diesel fuel diluent), distillation of cut-back

bitumen and road oil, ignition quality of Diesel fuel, knock-rating of aviation fuels (weak mixture), knock-rating of motor fuel, penetration of greases and petroleum, saponifiable matter, smoke-point and unsaponifiable matter in drying oils. Some minor alterations concern thermometers employed in determination of specific gravity ('I.P. 46W. Gravity Balance') and specific refractivity ('I.P. 45W. Refractometer').

The format of this volume follows much the same pattern as the eighth edition. Both arrangement and indexing reflect great credit on the editorial subcommittee and permanent officers of the Institution concerned. No one involved in routine investigation of petroleum and its products can afford to be without this latest "Standard". H. B. MILNER

CHEMISTRY OF ACETYLENE

The Chemistry of Acetylene and related Compounds

By Ernst David Bergmann. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. vii + 108. (New York and London: Interscience Publishers, Inc., 1948.) 18*s*.

THIS book is the latest representative of a series of short lecture-monographs. The title would seem to be rather grandiloquent for a work of this type; but, in fact, the author has managed to consider, albeit superficially, most of the reactions and transformations of this important class of organic compounds.

The first lecture enumerates the thermodynamical and physical data connected with the triple bond and also deals with addition to acetylenes, the 'iso-acetylene' hypothesis and the reactions exhibited by compounds containing the ethynyl group. The second discusses the addition of nitrogen compounds to acetylenes and then proceeds to give an admirable précis of the researches of Reppe. The work of the Weizmann school is described a little over-enthusiastically; but this is perhaps natural in a publication by one of its members. This latter section serves a useful purpose in making available the results of this school in a form for easy reference; hitherto they have been scattered throughout the patent literature. Many tantalizing references to unpublished work are mentioned; in particular, one awaits with considerable interest the details of the vapour-phase isomerization of dimethylethynylcarbinol to β-methylcrotonaldehyde. The last lecture describes the nature of the condensation catalyst employed by the Weizmann school and continues with a discussion of acetylenic polymers, including vinylacetylene and *cyclo*octatetraene; the book ends with a brief account of naturally occurring triply-bonded compounds. References are amply provided throughout.

The book is written in a highly personal manner, and many of the mechanisms accepted by the author must be considered to be still *sub judice*. The style is on the whole clear and concise, although irritating pedantries occasionally occur (for example, the use of 'analogon' for the far more usual 'analogue'). Over-compression has rendered one sentence (p. 88) completely beyond comprehension. The author succeeds in conveying the spectacular synthetic possibilities of the acetylenic compounds and the stimulating experience of working in this field.

R. A. RAPHAEL

THE ANODIZING OF ALUMINIUM

Werkstoff Aluminium und seine anodische Oxydation

Ein Handbuch und Ratgeber für den Praktiker. Von Dr. Max Schenk. Pp. 1042. (Bern: A. Francke A.-G., 1948.) 138 Swiss francs.

ALTHOUGH information on the technical reinforcement of the oxide film on aluminium and its alloys is to be found in papers in scientific publications, articles in trade journals, and patent specifications, it is often difficult to trace, and books on the subject are not numerous. The issue of Dr. Max Schenk's book, dealing with the subject comprehensively and critically, and written by an author having a wide knowledge of the processes involved, is therefore to be welcomed. It is primarily intended for the practical man, but is no mere compendium of technical processes and applications. Dr. Schenk holds the view that to understand the processes involved, to operate them successfully, and to make full use of the product, requires considerable knowledge of the chemistry and physics of aluminium and its compounds, coupled with some acquaintance with the various processes of fabrication to which the metal may have been subjected. The book accordingly comprises two sections, approximately equal in length, the first dealing with the structure, properties, and fabrication of the metal, and the second with the chemical and electro-chemical processes used to produce coherent oxide films and with the properties and applications of the product.

The first quarter of the book is devoted to the metallography and fabrication of aluminium and its alloys, and covers constitution, casting, rolling, heat-treatment, forming and methods of jointing. The descriptions of the processes are short but adequate, and the treatment is essentially practical. Thus figures and diagrams are given showing the effect of alloying and of processes such as cold working and heat treatment on the structure and properties of the product, while current theories on these subjects are given in outline but are not discussed at length. Stress is laid throughout on the behaviour of the product during anodizing, special attention being given to the effects of variations in processing conditions and of faults during fabrication. Useful tables are included giving the compositions and properties of commercial cast and wrought alloys, though so far as British alloys are concerned the list is by no means complete. Recommendations are also made for optimum working and annealing conditions, and for solution and precipitation treatments in the case of the heat-treatable alloys.

The next part of the book is devoted to general chemical theory, particularly electrochemistry, and is followed by an account of the chemistry of aluminium and its compounds. This section is comprehensive, clearly written, and well illustrated; and the chapters on the formation and properties of the oxide film should lead to a clear understanding of the technical processes and applications of anodizing. The section dealing with the chemical behaviour of aluminium and aluminium alloys towards various reagents includes no less than sixty-three pages of tables. The chapters on corrosion are detailed and lucid; but their value is lessened by the fact that research by other than German workers has been largely ignored.

The next section of the book, dealing with technical methods of forming the oxide film, opens with

a short but excellent account of the purely chemical processes, followed by a description of the nature and properties of films formed in various electrolytes under the application of direct or alternating electric current. The treatment is lucid and comprehensive, covering both theory and practice, and serves as an excellent introduction to a very detailed account of the commercial anodizing processes. This covers pretreatment, plant installation, operating conditions for various electrolytes, and after-treatments such as sealing, dyeing, and impregnation with inorganic pigments. Practical difficulties, whether arising from faults in the material or from errors during anodizing, are dealt with at length, and information is given on plant and process control, and on the testing of the product. The sections on process control are excellent; but those on testing leave something to be desired. Physical tests on anodized material are adequately described; but for assessing liability to corrosion, only accelerated tests such as the Mylius are considered, and nothing is said about their reliability. For chemical control of the metal to be anodized, the reader may be led to infer that qualitative spot tests are generally sufficient and that full quantitative analyses are rarely needed.

Applications of anodized aluminium in household ware, architecture, instrument-making and chemical plant are critically described, with reasoned statements on the most suitable type of film for each purpose. The book concludes with a chapter on the cost of plant, operation and upkeep.

The printing, binding and quality of illustrations leave nothing to be desired, even by pre-war standards, and one can only regret that the book is not in English and that the price is so high.

H. W. L. PHILLIPS

TAXONOMY AND EVOLUTION OF COTTON

The Evolution of Gossypium

And the Differentiation of the Cultivated Cottons. By J. B. Hutchinson, R. A. Silow and S. G. Stephens. Being the Final Report of the Genetics Department, Cotton Research Station, Trinidad, B.W.I. Pp. xi + 160. (London, New York and Toronto: Oxford University Press, 1947.) 15*s*. net.

THE function of the Empire Cotton Growing Corporation is to assist in the promotion of cotton-growing in the various countries of the British Empire or Commonwealth. This aim is largely realized by close co-operation with the local governing authorities in the various territories, by carrying out a wide programme of research designed to maintain or improve the quality of the crops and to increase yield by selection and initial expansion of new seed stocks, by overcoming and circumventing pest and disease attack, and by effecting improvements in many aspects of tropical and sub-tropical crop husbandry. The Corporation started a main Cotton Research Station in Trinidad in 1926 and encouraged fundamental studies in botany, plant physiology and genetics so that cotton breeders would have firmer foundations for their work on the commercial cotton crops. The increasing complexity of many modern problems necessitates a considerable extension in this side of the work of the Corporation. The Trinidad Station has been closed and a new, larger station is being established in Uganda, where closer contact with the field-workers in Africa may be made.

The transfer of activities from Trinidad to Uganda has caused a temporary but unavoidable halt in many activities. The joint authors of the book under notice have therefore taken this opportunity to review the progress made while they were working as a team in the Genetics Department in Trinidad, and to survey many lines along which future research could be usefully directed. Many of the authors' detailed investigations have been published separately from time to time. The present work reviews the genus *Gossypium* as a whole by covering its classification, evolution and present position on a basis broadened by critical use of much published work of other workers. For convenience, the book is divided into four main sections.

"The Wild and Cultivated Cotton Plants of the World" (1907), by Sir George Watt, is the almost classical monograph on the taxonomy of cotton. In the light of more recent advances in the field of genetics and cytology, coupled with morphological considerations, Hutchinson has revised the classification of the genus on a simplified basis, dividing it into eight sections, of which two contain the cultivated commercial cottons and six embrace the wild species.

The evolution of cotton is covered by Hutchinson and Stephens. Consideration is given to the identification of the major factors which governed the evolution of true 'commercial' cottons from the wild, and often virtually lintless, species. The origin of first the Old World cottons, with the basic chromosome number in the genus of $n = 13$, and then the New World cottons, with $n = 26$ chromosomes, comprising a set of thirteen homologous with the genom of the cultivated Old World species and a set of thirteen homologous with that of the wild American species, will prove of interest to many ethnologists as well as to biologists.

These evolutionary studies are pursued further by Hutchinson and Silow in the third section, which covers the differentiation of cotton, as the spinner knows it, into the complex of major and minor types by man.

In the last section, Hutchinson and Stephens consider how new characters arise and the part played by polyploidy. Brief consideration is given to the nature of genetic variability and to the question of its often desirable conservation when it may aid adaptation to varied local conditions. Many of the views expressed should be of both practical and general interest to breeders working on the present commercial types.

No doubt individual workers in the genetics of cotton may disagree in part with particular views held by the authors; but agreement will be general that a work of this type was long overdue, and that it will facilitate adequate interpretation of the many contributions made in this field in recent years. From the angle of the textile technologist, the basic groundwork of cotton genetics may seem to be a matter of academic rather than of practical interest. Nevertheless, only fundamental studies in the fields mentioned above will make it possible to effect major improvements in the present cottons of commerce by the formation or transference of desirable fibre characteristics, by inducing immunity to disease or resistance to pest attack, or by obtaining increased yields through greater adaptability to varied growth-conditions.

E. LORD

Physics

For Students of Science and Engineering. By Asst. Prof. William H. Michener. Pp. x+646. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 25*s*. 6*d*. net.

THIS is a text-book, of about intermediate standard, in which physical principles are illustrated more fully than usual by examples from everyday life. The author claims that he has tried to encourage the student to think for himself, and to this end has used the device of mentioning phenomena without explaining them. It is doubtful whether this device is successful. For example, the problem of a ping-pong ball supported on a jet of air (p. 135) is not one that the student should be expected to work out for himself; nor is that of the concentration of the scattering by a diffraction grating into one particular order (p. 353). Topics such as these are best omitted completely in an intermediate text-book.

Some of the diagrams are rather poorly drawn. On p. 343, for example, a lens system is shown with all the deviations produced at a single surface of each lens. On p. 364 a ray of light is shown being dispersed into three representative rays at one surface of a prism, these three then emerging from the other surface *parallel to each other*. Further, these parallel rays are caused to diverge by a converging lens! Such diagrams place the serious student at a disadvantage with respect to the casual reader.

In short, this text-book has some serious faults and does not appear to have any particular points to commend it in competition with the many others that exist.

Soilless Growth of Plants

By Carleton Ellis and M. W. Swaney. Second edition, revised and enlarged by Tom Eastwood. Pp. x+277. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 28*s*. 6*d*. net.

HYDROPONICS, or soil-less culture, has made considerable progress during the last ten years, especially in America and in areas where heat and drought make it difficult to produce vegetables under ordinary conditions of soil cultivation. While the first edition of Ellis and Swaney's book catered mainly for the amateur or general reader, Eastwood's revision deals largely with the commercial side. This revision has been so drastic that little of the original text remains; but there is no indication of this in the foreword or elsewhere, thus failing to give due credit to the original authors.

Many types of equipment have been developed for sub-irrigation and gravel culture methods, and in describing these, Eastwood indicates the weak, as well as the strong, points of the outfits, with the probable causes of failure where initial success has not been followed up in later work. Specially valuable are the practical working details for procuring the necessary chemicals, making up and analysing the nutrient solutions and the care of the apparatus needed. Plants grown in soil-less culture are not immune to many of the common pests and diseases, as is too often believed, and precautionary methods against them are suggested.

With the growing interest in soil-less cultures, this revision should be of much value to scientific workers, commercial growers and amateurs alike, as its insistence on practical details should help to overcome many of the difficulties inherent in the method. As a work of reference it should also play its part in the considerable advances that may be expected in hydroponics in the course of time. W. E. B.

The Ventilation of Bee-Hives

By E. B. Wedmore. Pp. 116. (Petts Wood: Bee Craft, Bracken Dene, Manor Way, 1947.) 7*s*. net.

MR. WEDMORE has done a further service to beekeepers by bringing together, discussing and criticizing in his latest book the available data on the subject of hive ventilation. This is a subject to which Mr. Wedmore has devoted considerable time and on which he speaks with authority. It is, of course, of the very greatest importance to a proper understanding of those conditions which are necessary to ensure satisfactory living conditions for colonies of hive-bees both in winter and summer.

The reader will be left in no doubt that the conclusions reached from analysis of the data on hive ventilation, which have so far been obtained, clearly support the application of the relatively spartan methods of wintering bees which are to-day advocated almost unanimously by the leading authorities both in Europe and in North America. It is of interest to students of beekeeping practice to note that these methods, which are still regarded with suspicion by some beekeepers, were employed and recommended by leading beekeepers so long as fifty years ago.

Besides discussing such matters as the form of the winter cluster, air currents within the hive, the disposal of water and carbon dioxide, and temperature control, the author also discusses such a practical matter as hive design.

This is a most stimulating book not only on account of the interesting analysis of the data presented but perhaps even more because of the gaps in our knowledge which such analysis discloses.

C. G. BUTLER

Genetics

By Dr. H. Kalmus, in collaboration with Lettice M. Crump. (Pelican Books, A.179.) Pp. 171. (Harmondsworth: Penguin Books, Ltd., 1948.) 1*s*. 6*d*.

GENETICS is one of the youngest, yet also one of the most actively developing, branches of biology. At present neither its own theoretical structure and internal consistency nor its importance for general biology and human affairs is widely appreciated outside the immediate circle of geneticists themselves. This is in a great measure due to the lack of books giving simple accounts of the subject, particularly in its broader connexions.

Dr. Kalmus' 'Pelican' should therefore command a wide audience. It is a formidable task to compress even an outline of genetics into 171 pages, and there are inevitably omissions and over-simplifications. The author is, however, to be congratulated on his attempt to include consideration of the wider implications as well as the narrower basis, even though in places his discussion may not commend itself to all his fellow geneticists. Care is taken to explain the genetical terms used, and a short glossary is given as well as suggestions for further reading. It has, however, proved impossible to explain all the more general biological terms which are used. The book, therefore, may well prove to be of greatest value to those who already have some biological background.

MOVEMENTS OF POPULATION IN THE BRITISH COMMONWEALTH

AT the Brighton meeting of the British Association, a symposium was arranged by Section E (Geography) on population movements in the British Commonwealth. Prof. C. B. Fawcett contributed a paper on the geographical aspects of the subject; Prof. Brinley Thomas (Section F: Economics) dealt with it from the point of view of an economist; and Mr. R. R. Rawson analysed the particular problem of White settlement on inter-tropical highlands, with special reference to Kenya and Rhodesia.

Prof. Fawcett introduced his analysis with the main facts about the distribution of population in the Commonwealth. He described it as the least densely peopled of the major political units of the world. More than half the total area consists of the arctic or sub-arctic regions of Canada, or the arid and semi-arid zones of Australia and South Africa. The Dominions, the total area of which covers about one-seventh of all the inhabited land, contain not more than one-fifteenth of the good agricultural land of the world. England, with its 40 million people on 50,000 square miles of land, that is to say, about 800 persons a square mile, is the most densely settled country in the world. The striking unevenness of the distribution of the population of the Commonwealth raises the question whether the younger Dominions are under-peopled.

In considering this very topical problem, Prof. Fawcett saw reason to approve measures such as the 'White Australia' policy. He stressed that any 'foreign' minorities which remain distinct communities in the population tend to lessen its social and political unity, and that the acute colour problems in South Africa and the United States are an object-lesson which justify Australians in their determination to keep out races difficult to assimilate. Prof. Fawcett doubted whether the economic effects of immigration are the most significant ones. To quote his words, "the colour problems of the United States and the communal differences of India are sufficient evidence that the world has not yet reached the level of civilization in which a plural society, with wide cultural or racial difference between its component communities, can form a satisfactory social or political unit of free people".

Prof. Fawcett cited with approval the following estimates of the probable populations which the Dominions could support at the present standards of living: Australia, 30–50 million; Canada, 60–100 million. In Australia the increase could be brought about in three ways: by closer rural settlement in the well-watered areas, expansion of tropical agriculture in the east coastal areas of Queensland, and industrial development based on mineral resources, especially coal. Britain could not be expected to supply agricultural migrants, in view of the drive to grow more food at home. Similarly, while full employment continues, there would be little chance of a large-scale transfer of industrial workers. After referring to the effect of social security and the demographic consequences of the pre-war fall in the birth-rate, Prof. Fawcett concluded that any considerable migration would accentuate the change in the balance between the lower and upper age-groups.

The next paper, "The Economics of Commonwealth Migration", was read by the present writer. The argument may be summarized as follows. Despite all the efforts made to people the Dominions with migrants from Britain, there was a net overflow of population from the British Empire to the rest of the world amounting to 5·9 million in the years 1836–1900 and 250,000 in the period 1901–36. Of the ten million British people who crossed the seas in the half-century 1845–1894, 68 per cent went to the United States, 16 per cent to Australia and New Zealand, and 12 per cent to Canada.

What were the main determinants of these migration movements? First, there was a sharp difference between the relative quantities of factors of production in the Old World and in new countries; the marginal productivity of labour overseas was much higher than it was in Europe. Secondly, capital exports tended to be accompanied by migration of labour. The last great burst of emigration from Britain coincided with the absorption of a considerable volume of capital by Canada, when the Prairie Provinces were being opened up in the early years of this century. Thirdly, the *direction* of the flow of British emigrants was strongly influenced by the contrast between the high degree of equality of opportunity in the United States and the class barriers in Great Britain. Under the influence of the ideas of Edward Gibbon Wakefield, British colonization policy was designed to reproduce in the oversea dependencies the social structure of the homeland. It met with little success because the facts in the Colonies were too strong for it. It was the discovery of gold, not the colonization theories of Whitehall, which gave a real impetus to the growth of Australia.

The inter-war period was dominated by the drastic immigration restrictions introduced by the United States in 1924. The consequences were far-reaching. Agricultural protectionism was stimulated in Europe, and capital from the United States was encouraged to flow to the Old World, since population was prevented from migrating to America. In these new circumstances the Empire settlement policy launched by the British Government led to disappointing results. The net amount of British emigration to the Empire fell from 113,000 in 1922 to 63,000 in 1929; and during the thirties the stream actually turned the other way, Britain receiving an *inward* balance of 126,000 migrants from the Dominions.

A cardinal weakness of the ideas underlying this policy of peopling the Empire was the failure to realize that Britain was no longer able to export capital on the appropriate scale. Moreover, a significant change was taking place in the economic relationship between agricultural and industrial countries. As the Western world became richer, a greater proportion of income was being devoted to amenities, and a smaller proportion to necessities; hence the growth of employment in personal services, distribution, entertainment, etc. Despite this trend, Empire migration policy continued to be based on extensive land settlement in the Dominions. This objective was not consistent with the new direction which was being given to the productive forces of the Western world by the rising level of affluence.

Against this background, the paper proceeded to an analysis of the bearing of migration on the current economic crisis, the hypothesis of a planned transfer of population for strategic reasons being left out of account. Large-scale emigration would weaken the lower age-groups which contain the most productive labour. It would be accompanied by an export of capital which would accentuate Great Britain's difficulties. In 1947, a year of severe crisis in the

balance of payments, no less than a third of the toll on British reserves was caused by export of capital, a good proportion of which consisted of emigrants' funds and money invested in Dominion securities. Moreover, by accentuating the scarcity of manpower in industries where the shortage is already keen, emigration tends to promote inflationary pressure.

The policy best calculated to help Britain overcome the crisis is one which would welcome appropriate grades of immigrants from the continent of Europe. A high rate of immigration makes up for a low degree of internal mobility. The argument that these newcomers would be a strain on the British economy since they have to be fed and housed does not bear analysis. They are prepared to work in industries producing the most essential output—coal, textiles, food—and they are accommodated in existing premises. The value of the marginal product of immigrant labour of this kind much exceeds the cost of the imports and capital equipment needed for its employment.

Finally, there is the long-run question whether Britain can hope to sustain a population of fifty million at anything like the old standard of living when outside help is no longer available. Much will depend on the future course of the terms of trade. There are strong reasons for taking a pessimistic view. The industrializing of agricultural countries will tend to reduce exports of food from these countries. A study of the stages through which the United States has passed is instructive. In poor countries like India, the peasants may sell less of their crops on the market as the price improves; they will wish to consume more themselves. Then, the principle of 'fair shares' in the allocation of food as between rich and poor nations augurs ill for the highly industrialized countries like Britain. These tendencies operating unchecked mean a continuance of dear food for the British people: whether this can be masked indefinitely by a policy of internal subsidies is questionable.

On the other hand, it may be that the world is on the eve of a great advance in the application of science to crop production. Moreover, the long-term trend in consumption habits noted in the inter-war period may yet reassert itself. The most reasonable expectation is that the terms of trade for Britain will fall somewhat from their present level, but will never again reach the favourable ratio experienced between the two World Wars. If the people respond to this stern challenge by increasing and rearranging their productive power, there is no reason why a tolerable equilibrium cannot be found for a population of fifty million. There need be no mass emigration.

In the third paper in the symposium, Mr. R. R. Rawson considered in detail the factors determining White settlement in Kenya and Rhodesia. Looking to the future, he saw signs of a more considerable White settlement in East Africa for strategic reasons; but in view of the lack of mineral resources in Kenya, such a plan would entail linking Kenya with the coal and iron deposits of Rhodesia.

The open discussion ranged widely over the ground covered by the three papers. One of the questions treated in detail was the future of the terms on which Britain can expect to purchase imported food. Reference was made to the views of authorities in other Sections of the British Association, who had pointed out that the effective supply of food could be greatly increased if the heavy loss due to destruction by vermin could be partly eliminated. It was significant to observe the attention devoted to the food problem in this symposium, as in other sessions during the British Association meeting at Brighton. On the question of the White Australia policy, a representative of Section H (Anthropology) disagreed with Prof. Fawcett and argued that the difficulties of assimilating coloured peoples must not be shirked. Finally, I had the feeling that Prof. Fawcett's suggestion that Australia could increase her population to 30–50 million, and Canada to 60–100 million, was much too optimistic. A careful assessment of the probable economic trends seems to be necessary before such estimates can be put forward with any confidence.

BRINLEY THOMAS

PHYSICAL CHEMISTRY OF PROCESS METALLURGY

THE discussion on "The Physical Chemistry of Process Metallurgy", which the Faraday Society held at Ashorne Hill, Warwickshire, during September 23–25, showed plainly that process metallurgy is now as much the province of the physical chemist as the metallurgist. Attention at this meeting was devoted almost entirely to the high-temperature processes involved in the winning and refining of metals, and here in particular it seems that advances will come mainly from the application of physical chemistry. Indeed, speaking as a steelmaker, Sir Andrew McCance (Colvilles, Ltd.) confirmed, in his introductory remarks, that the advances in the open-hearth process over the past twenty years have come almost entirely from the physico-chemical approach to open-hearth reactions. In this article it is intended to touch only upon the main topics of physico-chemical interest. In so short a space it is impossible to consider all the problems discussed, and reference will not be made to those papers concerned with industrial applications.

After an opening paper by Sir Charles Goodeve (British Iron and Steel Research Association), outlining the physico-chemical principles of special importance in this field, the subject was considered in three main sections: metallic solutions; roasting and reduction processes; and slags and refining processes. In addition, a number of papers dealt with the problems associated with experimental work in the important temperature-range between 1,000° C. and 2,000° C. The main difficulty in handling substances at these high temperatures is finding refractory containers which will not react with them. Almost all substances become chemically reactive in such extreme conditions, since high activation energies for molecular processes are no longer seriously restrictive. Another less obvious problem, which has caused large errors in the results of many equilibrium studies between gas mixtures and metals or slags, is thermal diffusion. This is caused by the large temperature gradients which are generally unavoidable in any apparatus operating under these conditions. The heavier components in the gas mixtures used diffuse away from the hot zone, and so set up concentration differences in the apparatus which may be maintained even under steady flow conditions. These differences can be avoided by combining adequate preheating of the incoming gas with a flow-rate sufficient to prevent any significant concentration gradients from becoming established. They can also be greatly reduced, as

shown by Mr. M. N. Dastur and Prof. J. Chipman (Massachusetts Institute of Technology) in a paper dealing specifically with the problem, by the addition of a heavy inactive gas, such as argon, to the mixture.

The present state of our knowledge of solid metallic solutions is rather different from that of liquid solutions. For solid solutions we frequently have a structure which has been determined precisely by X-rays, and an exact knowledge of the conditions under which one structure becomes unstable relative to another. As pointed out by Dr. R. M. Barrer (Bedford College, London), simple spatial considerations, such as the ratio of the radius of the interstitial atom to that of the metal atom, lead to a reasonably clear understanding of the type of structure which will be assumed. In contrast, our knowledge of the chemical potentials of solutes in such solid solutions is fragmentary, to say the least. In the liquid state the reverse is the case; for, as Prof. Chipman showed, there are now a reasonable number of such solutions for which the thermodynamic data are satisfactory. On the other hand, we have no exact model for our liquid solution, and can only suppose that it differs from the solid mainly due to the relaxation of spatial restrictions, brought about by melting. This accounts, of course, for the marked increase on melting in the solubility of substances present as interstitial atoms; but this very relaxation makes it difficult to interpret the marked effect of one solute on the activity of another, as described in the papers by Prof. Chipman and by Dr. J. A. Kitchener, Dr. J. O'M. Bockris and Mr. A. Liberman (Imperial College, London).

From the point of view of process metallurgy, kinetic aspects are mainly of interest at low temperatures in the solid state. At high temperatures, diffusion usually controls the rate for processes involving solids, and convection for those involving liquids. This can readily be appreciated when it is remembered that at 1,600° C., for example, no less than one collision in 10^4 is energetically suitable for an activation energy of 50 kilocalories, as compared with one in 10^{14} at 500° C. The most commonly investigated property of solid solutions is the diffusion of solute atoms in the metal lattice. The property most frequently measured, however, is the movement of the solute through a thin sheet of metal; but this, as Dr. Barrer stressed, is often governed more by surface processes than by lattice diffusion. A good example was provided by Sir Charles Goodeve and Mr. K. H. Jack (British Iron and Steel Research Association), who reported that the slowest step in the evolution of nitrogen from an iron–nitrogen alloy (the ε phase of the iron–nitrogen system) is the combination of pairs of nitrogen atoms at the surface. In the presence of hydrogen gas, which appears to render this combination process unnecessary, the evolution is 10^4 times faster, and lattice diffusion becomes rate-determining to some extent.

The value of thermodynamics in the design of metallurgical processes was brought out strongly in the section on roasting and reduction. Its application is particularly important in the reduction of refractory oxides for winning such metals as magnesium, titanium and vanadium. A good example was provided by Prof. L. M. Pidgeon and Dr. J. A. King (Toronto), who reported their studies of the equilibrium:

$$2MgO + 2CaO + Si\ (Fe) = Ca_2SiO_4 + 2Mg_{(g)} + (Fe).$$

This is the basic reaction for the Pidgeon process, which was used in Canada during the War for making magnesium from dolomite and ferrosilicon. The pressure of magnesium developed by this reaction at 1,200° C. is 19 mm., as compared with 1·9 mm. for the reaction,

$$4MgO + Si = 2Mg_{(v)} + Mg_2SiO_4,$$

which was investigated in Germany in 1940. The reason for the difference lies, of course, in the far more negative free energy of formation of the calcium than the magnesium silicate.

The method of representation of free energy data is important for those concerned with the extractive processes. Two methods were discussed at the meeting; one the plot of ΔG° against T, which was illustrated by Prof. C. W. Dannatt (Royal School of Mines, London) and Dr. H. J. T. Ellingham (Royal Institute of Chemistry, London) in their introductory paper to this section, and the other the plot of $\log K$ against $1/T$, which was used by Dr. M. J. N. Pourbaix and Madame C. Rorive-Boute (Brussels) in describing a series of oxide systems. Although each method has its merits, it would seem desirable to select one as standard, since the graphical representation of collected data is certain to become of increasing importance. In the light of the discussion, the ΔG°, T plot would seem to be of more general application, since it can include data for a wide variety of systems in one diagram. With complex processes this makes it possible to distinguish at a glance the important equilibria from the unimportant, and to see how the systems change as temperature and pressure are altered.

Dr. P. Gross and Messrs. C. S. Campbell, D. L. Levi and P. J. C. Kent (Fulmer Research Institute) reported some interesting work on the thermodynamics of aluminium halides by measurements of the reaction pressures set up by equilibria of the type:

$$NaCl_{(solid)} + Al_{(liquid)} = Na_{(vapour)} + AlCl_{(gas)}.$$

Direct measurements of the pressure are not possible on account of the reactive character of the halides, so they had to adopt an unusual experimental technique. The unknown gas–solid equilibrium, together with a known one which does not interfere with it, was allowed to establish itself in an evacuated vessel closed except for a capillary outlet. This outlet served as a slow escape for the equilibrium gas mixture, which was collected in a suitable condenser on emerging from the capillary. The ratio of the unknown pressure to the known was determined by analysis of the condensate, the known pressure in this case being the vapour pressure of the alkali halide.

The primary reactions which occur in roasting and reduction processes were described by Dr. J. S. Anderson (Atomic Energy Research Establishment, Harwell) in terms of the lattice defects which can occur in ionic crystals, and particularly oxides and sulphides. For these materials the stoichiometric compound is a special case, and in general there is either a very small excess of oxygen in the lattice associated with cation holes, or excess of metal as interstitial metal atoms. In the light of this knowledge the reduction process may be considered as taking place in the following stages. First there is chemisorption of hydrogen or carbon monoxide at the surface as hydroxyl or carbonate ions, as proposed by Garner, the additional valence electrons being accommodated by lowering the valency of one or more cations and thus creating lattice defects in

the surface. These defects now migrate into the lattice and increase in concentration until saturation is reached, and metal or lower oxide forms as a new phase. In roasting sulphides one would similarly expect that oxygen ions would first be formed on the surface, creating cation holes within the lattice. This would be followed by destruction of the positive holes as oxides of sulphur are eliminated, and the resultant building of oxygen into the lattice in place of sulphur. Studies of the roasting of copper sulphides by a new method reported by Prof. E. A. Peretti (Notre Dame, Indiana) are in line with this picture, for they show that the reaction proceeds directly from cupric to cuprous sulphide and finally to cuprous oxide, and not via the formation of sulphates as previously believed.

Our present understanding of liquid slags is far from adequate. This can be attributed partly to the fact that ionic melts in general have received little attention from the physical chemist, and partly to the great difficulties which arise in making controlled experiments with materials which attack containers of all types. As Dr. F. D. Richardson (British Iron and Steel Research Association) pointed out, our ideas of liquid slag structures are based essentially on our knowledge of the structures of crystalline silicates, phosphates and aluminates, and the recognition that the liquid state differs from the solid mainly in lacking any long-range order. This picture is corroborated by X-ray work on silica glasses, which have been shown to consist of random networks of silicate tetrahedra with metallic cations located in the holes between them. The chemical potentials of the components of slags have in some cases been determined by slag-metal equilibrium measurements. For binary systems they can be obtained less directly from phase diagrams, and interesting results derived in this way were reported by Prof. M. Rey (École des Mines, Paris). The standard states for some of the oxides and sulphides of importance in slags present a problem in cases such as ferrous oxide (FeO) and iron sulphide (FeS), which can exist over wide ranges of composition depending on the equilibrium oxygen or sulphur pressures. Although failure to take account of such non-stoichiometric variations may not lead to large errors in total free energy changes, it was stressed by Dr. G. M. Willis (Melbourne) that large errors may be caused in the partial molar free energies of components in slag melts. An ionic view of slags has been developing in recent years, and although, as Prof. E. A. Guggenheim (Reading) pointed out, it is irrelevant, so far as slag-metal equilibria are concerned, whether the various atoms or atom groupings are ionized or not, knowledge of the ionic constitution is helpful in developing a detailed model of slag melts, and may, indeed, be of practical importance in arc furnaces. Dr. J. A. Kitchener, Dr. J. O'M. Bockris and Messrs. J. Tomlinson and S. Ignatowicz (Imperial College, London) reported measurements of the electrical conductivity of binary silicate melts, which indicate that the conduction is mainly ionic. It increases more than one-hundredfold at the melting point for calcium and manganese silicates, and shows a temperature coefficient compatible with the view that the conductivities are due to the small, relatively mobile cations, and the viscosities to the large, relatively immobile anions.

All those concerned with the application of physical chemistry to process metallurgy owe a great debt to the Faraday Society for arranging this discussion. Apart from the stimulating effect of bringing together workers in this field from many laboratories and many different countries, it has brought the criticisms and ideas of physical chemists outside this field to those who are now working in it. It is to be hoped that the discussion will also stimulate physical chemists generally to take a new interest in the fundamentals of some of these interesting high-temperature systems.

F. D. RICHARDSON

VETERINARY EDUCATION: DEVELOPMENTS AT CAMBRIDGE

By DR. JAMES T. EDWARDS

THE address before us* breathes a freshness of outlook which bestirs the imagination of those who have watched a public awakening into the need for finding a healthy solution to a problem which, since the onset of the Industrial Revolution, and even before then, has been treated in Great Britain, to its sad discredit, with sore neglect.

This problem is concerned not only with the 'doctoring of animals', the pursuit which the ordinary member of our public associates with the designation 'vet.'. That in itself, it can never be too strongly emphasized, is an art which calls forth all the skill that is born of long and close experience, all the powers of keen and careful observation, and all the moral virtues of sympathy and kindliness which the human faculties can muster. It is an art which in the course of its long history has seen its periods of great triumph and of respect in the eyes of society, and its periods of utter debasement. Its triumphant periods have been within the histories of great empires at the height of their glory—the Buddhist, the Byzantine, and the Arab; and, let us hope, the British Commonwealth, as it is now marching to higher destiny, will be added to them. One of the worst, if not the worst and most infamous, of the periods in which the art suffered degradation was that in which the Church dominated thought and conduct in the Western world—the Dark Ages. Let us insist at once that this decline in respect for the art did not owe its origin to the Christian ethic, with its dominant note of 'charity'. Compounding for it a doctrine in which the ingredients were not incompatible with persisting Mediterranean cults and contained an infusion of neo-Platonism with some tincture of Christianity, the early Church Fathers, in their wisdom, shrewdly mindful of means of fostering moral uplift among peoples as they were at that time, founded a powerful hierarchy. This hierarchy increasingly in its interest played hard on the Platonic concept of the 'soul' as a higher state of being, which was immortal, and did not pertain to the 'beasts', which in their suffering were therefore denied both pity and mercy. (This theme has been well developed recently by the eminent French scholar and experienced veterinarian Emmanuel Leclainche in his book, "Histoire de la Médecine Vétérinaire" (Toulouse: Office du Livre, rue Alsace-Lorraine, 42; 1936).) The human physicians were hence eagerly absorbed into the Church, and their learning became that of the Church, disdaining craftsmanship and the knowledge which Plato's

* Veterinary Education. An Inaugural Lecture. By Prof. W. I. B. Beveridge. Pp. 40. (Cambridge: At the University Press, 1948.) 1s. 6d. net.

contemporary, Aristotle, had proved could be so richly garnered for the benefit of mankind from observation on the 'brute creation'. It was not until well into the eighteenth century that craftsmanship became elevated in esteem as a branch of the healing art with the rise of the surgeons from their lowly standing of barber-surgeons. Nothing of this sort had occurred in the older civilizations where, in the Arab Empire, for example, the arts of healing, both of man and animal, were taught side by side, with equal respect, in her great universities, from Baghdad to Salamanca.

After the fall of Rome, and the lapse into disuse of her magnificent road communications with the lethargy that then beset humanity, the Western world broke up into isolated communities, governed, or tyrannized, by baronial courts, the chief officials in each of which were the chamberlains, seneschals and marshals. It was to the marshals that was consigned the important office of charge of the cavalry, comprising both the management and treatment of the horses. From about the eighth century B.C., beginning in Babylonia, right up to the First World War, the use of cavalry in warfare, supplying as it did to this vital enterprise mobility and striking power, had been a main concern of rulers and States. Epidemic disease among horses, of which the chief was glanders, hampered campaigns and so encompassed gravely their existence. During the period of the Crusades, with the discovery of the art of horse-shoeing and the need for preserving cavalry on the march for long distances, a new class of menial assistants to the marshals arose who, besides acquiring proficiency in the craft of making and nailing-on (*ferrer*) iron horse-shoes, were also entrusted by their masters with the more laborious duties in treatment, such as the dressing of wounds and drenching of potions. These farriers, as they came to be called, soon, in the way of human nature, supplanted their trusting, well-bred masters, the marshals, usurping as they did in France a title common to both—*maréchal-ferrant*. Doubtless among them there were to be found many observant and worthy practitioners; but, on the whole, throughout Western countries they came to be looked upon as an ignorant class recruited from the most depraved strata of the public such as the knackermen and hangmen. The brutality of their treatments, matched only by their exorbitant charges as fees, was such that, as has been well said (McFadyean, 1923), the most fortunate animals before the opening of the veterinary schools in Western Europe during the latter half of the eighteenth century were those which escaped notice by that class.

There was no dearth of good literature to be consulted, such as the remarkable symposium recorded in the "Hippiatrika" by the Byzantine hippiatrists, and emended and plagiarized in various ways throughout the Middle Ages by successive authors. Yet, strangely, the literature which was produced and obtained a large circulation, such as that of the notorious impostor, Gervase Markham (1568–1637), was of the vilest, all diseases being assigned meaningless names and little description; but, for all there was an 'infallible' cure that had been a long-guarded 'secret', and was a shameful polypharmacy calculated to assuage and exploit superstition and credulity.

An exception to this lamentable story of the West was to be seen in Spain during the days of her greatness as a world power, where the Catholic monarchs, after the expulsion of the Moors, were careful in their own interest to preserve what was best from the Arab civilization they had conquered. Among this best was a well-educated and highly disciplined profession ministering to the domesticated animals, in particular the horse, to the governing body of which profession (the *Protoalbeitariat*) they graciously accorded their own patronage. It was not until 1813 when the Spanish Cortes, meeting at Cadiz, decided, in an excess of liberalism, to abolish all corporate institutions that this valuable profession became disrupted, never again to recover its former dignity and usefulness.

Meanwhile, concern was being felt in another way with the appallingly low state into which the healing art ministering to the animal world in the West had fallen. This concern was being felt not only by rulers and States but also by those whose interest it was to preserve the herds and flocks upon which the lives and prosperity of peoples so largely depended. From time immemorial, recurrent waves of devastating plagues among the domesticated animals had been known, the most serious of these being cattle plague (or rinderpest). As evidence of the concern of rulers may be cited that of Frederick the Great, who on return in 1767 from his Silesia campaign in the Seven Years War and fresh from witnessing the devastation caused by cattle plague and the consequent horrors suffered by the civil population, requested the Medical Faculty in Berlin to draw up plans for the opening of a veterinary school. This the professors of the Faculty did reluctantly, but added at once, almost reproachfully, that it was hoped it was not to be further expected of them to soil their hands in the carcases of beasts. The low ebb of affairs in this respect in Britain was decried by the wise and observant physician, Sir Thomas Browne (1605–82) (Smith, F., "The Early History of Veterinary Literature and its British Development", **1**, 311; 1919), the author of "Religio Medici", who in his book "Pseudodoxia Epidemica" bewailed the ignorance of the 'common farriers' to whom only recourse could be had by stockowners at the time, and appealed for the raising of a new class whom he designated by a term new to the language, 'good veterinarians'. Drawing on his massive classical scholarship, he had introduced a word which was held in repute in the earlier history of Rome, signifying a cattle husbandman. The solid farming peoples from whom Rome then derived her man-power were much attached to their cattle, the older, more mature, of which (the *veterini*) they prized for their tillage, their respected attendant being the *veterinarius*.

In Britain, concern was felt not so much by its rulers or its Government, as by the rising agricultural societies, one of which, the Odiham Agricultural Society of Hampshire, initiated the movement for starting veterinary education in England, while, later in Scotland, the Highland and Agricultural Society lent its powerful patronage to William Dick when he started a school in Edinburgh in 1823.

A Board of General Officers, sitting in London in 1796, decided that the best term to use for the educated recruits drafted urgently from the London Veterinary College, that had been opened in 1791, for care and treatment of cavalry and artillery horses in the Napoleonic War was 'veterinary surgeons', to distinguish them as a corps apart from the surgeons, who until then had been displaying keen interest also in that work. The designation was afterwards taken up enthusiastically by fellow practitioners among the civil population. As the late Sir Frederick Smith (1857–1929), the meticulously accurate veter-

inary historian, rightly insisted, however, the designation is a misnomer, for the practitioner of the healing art among animals has ever been more of a 'physician' than a 'surgeon'. Prof. Beveridge in his address contends that the name was not "a happy choice". We may agree, to some extent, however, with Leclainche in concluding that the very lack of precise meaning in it commends it; and, further, it has a safe position in language inasmuch as most countries have introduced it into their language and so it has gained the sanction of widespread usage. The powerful sanction of usage need not, however, we can now better realize, compel ultimately refusal to employ some more explicit name when that is really needed. In Britain, for example, what was long called the Veterinary Branch of the Board (now the Ministry) of Agriculture has come to be known as the Division of Animal Health. From its foundation in 1884, a similar great organisation in the United States has been known as the Federal Bureau of Animal Industry.

The Charter of Incorporation of Veterinary Surgeons, 1844, which gave legal recognition to the title of 'Veterinary Surgeons' as the exclusive designation of those who qualified from the veterinary colleges after passing an examination held by an elected Council of their body, was not confirmed by Statute until the passing of the Veterinary Surgeons Act, 1881, when in protecting the title 'veterinary', the exclusive right to use which had been allowed to lapse, a considerable body of unqualified people were brought on the register as 'Existing Practitioners'. The Act did not debar anyone, however, from undertaking veterinary practice so long as he did not use the title. In some progressive countries for a long time the veterinary profession has enjoyed the privileges of a 'closed shop', and it is one of the aims of the Veterinary Surgeons Act which has just become law to secure the same privileges for the veterinary profession in Great Britain.

To revert to the low ebb of affairs generally prevailing in Europe until well into the eighteenth century: there was, as we have seen, a widespread and periodically deeply felt need for the supply of enlightened and skilled men to control pestilence among animals; and, as the late Sir George Newman rightly said in regard to his own calling, "pestilence has always been the opportunity of medicine". It is an opportunity, as all who have had intimate experience of the subject well know, that has to be quickly seized, for the public soon forgets once the danger is over. It has to be remembered, too, that in human medicine matters were little better, for until 1745 there was no formal medical education in England, and thenceforward until 1782 what little that was given was imparted at private schools. Now and again, there were forthcoming highly gifted men, without special training for the purpose, who as if by intuition divined and applied wholly appropriate measures for controlling disease. For example, in 1714, Thomas Bates, surgeon to the King, by resolutely applying the model system of 'stamping-out' contagion outlined by the Papal physician, Lancisi, in 1711, succeeded in eradicating quickly cattle plague from England. When about thirty years later the disease reappeared, recurring afterwards until near the close of the century, when war prevented importations of live cattle, Bates's successful experience had been forgotten or overlooked. The natural disappearance of important cattle epidemics, it may be stressed here, from Great Britain during the last part of the eighteenth century and until the beginning of the fifth decade in the nineteenth century was largely responsible for Government and organised societies losing interest for a long time in veterinary education and for its consequent falling after its inception in England in 1791 into unworthy and incompetent hands, a setback from which it never fully recovered, even to this day. James Clark, of Edinburgh, 'Farrier' to the King for Scotland, who, according to Sir Frederick Smith, may "well and truly be described as the father of Veterinary Hygiene, not only in this country but in Europe", published, in 1788, a work on the "Prevention of Disease" which is a revelation. It was doubtless the application later of the principles of ventilation to stables advocated by Clark which brought about the rapid decline of glanders and other respiratory infections in Army horses.

What is important so far as we are concerned in criticizing the work under review is—what is not emphasized in it or, for that matter, in any recent document—that the universities throughout Christendom themselves took no heed whatever of this prevailing deplorable state of affairs, for which learning and inquiry of the highest order were sorely needed. They were, on the whole, not only apathetic, but disdainful, even hostile. Several examples could be readily given if space permitted.

It was not until the twentieth century had opened that the universities awakened, and then almost everywhere in the world, to a realization that the pursuit was worthy of the exercise to the fullest of such powers as were possessed by men and women of first-rate intelligence and general education, and that they must no longer keep aloof. Of all the larger territories, Australia, at Sydney and Melbourne (though this latter school is now closed), has shown outstanding willingness to aid advance of the pursuit by its universities. But already there is much to record in the experiences of several other countries upon the association of the universities with veterinary teaching. Britain has lagged; but there have been peculiar difficulties.

How, in the meantime, veterinary education developed has been well touched upon in the address under review, and it would exceed the compass of a short article even to give a bare summary of the complicated story. The time was doubtless ripe during the latter half of the eighteenth century for it to begin, as it did, with the opening of a veterinary school at Lyons in France in 1761, and the historian can now well discern that elsewhere it made many very bad beginnings. The paramountcy of the horse, which came about with the improvement of road communications early in the nineteenth century, when the Industrial Revolution got into full swing, followed later by decline of the horse which came about early in the present century with the mechanization of road transport, have been major phenomena that have strongly impressed themselves on the trend of developments. The Agricultural Revolution, which coincided with the Industrial Revolution and largely resulted from it, is another phenomenon, the importance of which had been largely masked and ignored in veterinary developments by deflexion of interest, often entirely, to the former one of the ascendancy of the horse. What this Revolution brought in its train was a complete change in the livestock husbandry of Britain and, indeed, of almost all countries, the exceptions being those countries like India and Egypt which still employ cattle mainly as a source

of motive power in agricultural operations. Otherwise, with the aggregation of large masses of people in towns which needed feeding, and with the enclosure of the commons and the abandonment of the open field system of farming, and, again, with provision for winter feeding of stock, consequent on storage of fodder and introduction of root crops, no less than the temporary absence, as already indicated, of major plagues, the cattle became transformed, largely through the genius of breeders like Robert Bakewell (1725–95) into types that were destined to meet the clamour of the towns for food, namely, meat and milk. England from being a wool- and wheat-exporting country for centuries had now new assets and new outlets, a prime asset being no longer her sheep, and wheat had to become an imported commodity of first magnitude. The invention of refrigeration, which enabled meat supplies to come from abroad, and the improvement of internal transport, so that milch cows need no longer be kept in cities, have again changed the problem confronting the veterinarian, who, paradoxically, with each succeeding change that seemed to foredoom his calling to extinction, has found himself confronted with a transformed yet ever-expanding field for enterprise.

Great triumphs lie already to his credit: in Britain, cattle plague was eradicated, after it was again introduced after a long lapse in 1865, when heed was paid at last to his counsel, so that when in 1870 it reappeared it was promptly eradicated. The legislation introduced at that time laid the foundation for State veterinary control of animal disease in Great Britain. Glanders again was eradicated in 1913; besides, nearly all the other major plagues, like bovine pleuropneumonia, rabies and sheep-pox, had by then been eliminated. Foot-and-mouth disease has been several times eradicated; but difficulties lie in preventing re-introduction with imported animal products. There remains, however, a mass of insidious disease which is very seriously limiting productivity and is sometimes a grave direct danger to man himself. Tuberculosis has become rampant among our cattle herds; but there seems no reason, particularly in the light of experience gained abroad, in the United States of America, Finland and Norway, why it should not be eradicated in time, effective legislation to bring about that result having been introduced only in 1935. Besides tuberculosis, other serious diseases affecting our dairy herds are sterility, contagious abortion, mastitis and Johne's disease, and much has been achieved already in better understanding of them and devising control. Great success has followed proper investigation, within the last three decades, of the diseases of sheep. Pig diseases are, for the most part, well in hand. In countries abroad, there have been magnificent achievements. Striking examples which may be cited are, first, in the United States, besides the suppression of tuberculosis in cattle, still earlier, following brilliant research, the eradication of Texas fever, a disease which afflicted the southern States to such an extent that economic cattle-raising had become impossible; secondly, wisely guided by the statesmanship of Botha and Smuts after the Boer War, the abundant financial resources available from the Rand were deflected without stint towards ridding the country of animal diseases which were playing havoc with its development as an agricultural country; and, in this endeavour, the successes which attended the labours of the late Sir Arnold Theiler and his disciples exceeded all anticipation.

Knowledge in nearly all departments has so far advanced within the last few decades that we can discern more clearly wherein skill of the kind that is to be derived from a sound veterinary education can be placed at the service of humanity. First, advances in nutritional science have been enormous, and they indicate plainly that a large proportion of the human race lacks adequate and proper feeding, without which there must be physical deterioration inescapably predetermining mental and moral enfeeblement. The stage at which this must be rectified is at the earliest, from conception, the pregnant and nursing mother and young offspring being highly vulnerable towards inadequacy of dietary constituents comprising especially first-class protein and several other substances the richest sources of which are milk, eggs, butter, cheese and other products of animal origin. A standard of living needs to be attained, therefore, at which there shall be no lack of these ingredients, and animal life consequently needs to be safely and economically propagated to meet all requirements. At present, animal life in the world falls very far short of being safe or fully economic to the producers.

Secondly, what to the anthropologist or archæologist has been a minute span of human history, namely, the period since the Industrial Revolution, has been fraught with enormous changes in the relationship of man to his environment, and ecologically it is a grave question whether the powers of any species, including the human species, for readjustment can withstand the strain of such a drastic change. Symptomatic probably of the strain in adjustment is a phenomenon that has come prominently into veterinary experience and, incidentally, proved pecuniarily remunerative, namely, the craving of the urban classes, from the humblest to the richest, for professional attention upon their household pets—dogs and cats. This source of revenue has more than compensated the profession in England for the disappearance of the horse, and, during the interval between the two world wars, when Government allowed agriculture to lapse almost into a state of insolvency so that farmers could not easily pay for veterinary attention, the newly opened source must have saved the veterinary profession itself, as to a very fair proportion of its members, from dire financial straits. Some social historians have emphasized that the migration of the rural population of England into the towns after the Industrial Revolution was an unmitigated evil, in so far as childhood experience then was not passed, as it had been immemorially, in close relationship with the numbers of other species which the ecologist finds essential for the continuance of any species. All that, of course, awaits inquiry by workers in the several branches of the social sciences. One cannot but be impressed in a country like Egypt, where the great masses of the people—the *fellaheen*—persist still in a state akin to that of pre-Industrial England, with the serenity of countenance that generally characterizes those masses, compared with the strained, almost tormented, expressions of those inhabitants in the few large cities who are emulating the present urban luxury standards of the West. The maintenance of a numerous and healthy rural population everywhere may therefore prove on proper investigation to be the highest achievement of good statesmanship in the present troubled state of the world; and, interspersed among that population to guide it, will be needed numerous veterinarians. Countries like Holland, Switzerland, Hungary and

the Scandinavian countries generally have perceived things already in that way and made provision for veterinary education at State expense out of all proportion to what was expended on the "starved and neglected" (to quote departmental committee reports) veterinary colleges in Great Britain in the past.

If one proceeds to make a proper 'job-analysis', then it will be found that to turn out veterinarians to meet the transformed and expanding situation the final objective of the necessary training is three-fold, being concerned with, first, clinical practice ('the doctoring of animals'); secondly, preventive medicine (or public control of the pestilences, grave or insidious, of the kind already mentioned); and thirdly, live-stock husbandry and economy (of no less public significance than the former divisions and essential to meet the social circumstances as they are unfolding themselves). A whole array of sciences, many of which have only just emerged as sciences in their own right, such as animal nutrition, genetics, comparative psychology, endocrinology, need to have their proper place in the curriculum of teaching leading to the vocational objectives. Mere minor readjustments in the traditional curriculum are out of place; but what is called for is rather a complete resetting, bearing always in mind the time in the trainee's life that ought not to be exceeded and the expense and the important question of his or her natural aptitude.

Prof. Beveridge in his address has very well perceived many of the implications of the changed situation. The Veterinary Surgeons Act which has just been passed will give him ample freedom within the jurisdiction of a great university to develop his plans, and in all that endeavour he may be well assured of the good wishes and goodwill of his British colleagues. That that university should have thought fit to appoint a countryman of the daughter Dominion of Australia to launch its plans for a complete veterinary education on securing at last full legal sanction to do so is a gesture that will appeal both to the good sense and to the finer sentiments of everyone in Great Britain. Even if space allowed, digression upon the recent history of the several transactions which have ultimately led to the establishment of this teaching at Cambridge would be tedious. However, finally, even in the shortest notice, to omit paying respectful homage to the memory of the late Sir Clifford Allbutt, regius professor of physic at Cambridge, who worked hard during his long life to achieve this end, would be ungracious, now that that end he strove so hard for has come in sight.

OBITUARIES

Prof. Ruth Benedict

THE death on September 17 of Ruth Fulton Benedict at the comparatively early age of sixty-one deprives social anthropology of one of its most stimulating writers and thinkers. Ruth Benedict was one of the many American anthropologists who took their early training at Columbia University under the late Franz Boas, and she remained attached to that University all her life, ending her days as the holder of a chair in the Anthropological Department.

Ruth Benedict was a vigorous teacher as well as a woman of distinction and charm. In her youth she did field-work among the Zuni of New Mexico and wrote a series of monographs on them. She will, however, be chiefly remembered for her original and provocative book "Patterns of Culture", published in 1934; "Race and Racism", published during the War; and "The Chrysanthemum and the Sword", an analysis of Japanese character which appeared last year.

The fashion of her day was the conventional type of ethnographic monograph; but she early cut away from these and marched boldly out on to the frontier between psychology and anthropology. She was interested from the first in the infinite diversity of values and behaviour patterns which are found in cultures of different types. She believed that these ideals and attitudes formed a coherent whole to which she gave the title 'culture pattern'. She suggested that cultures could be grouped into types on the basis of these patterns. Cultures might be described as Apolonian, Dyonisac or Paranoiac, for example, or they could be classified as 'shame' or 'guilt' societies. The individual brought up in such societies was shaped to their dominant pattern.

Ruth Benedict never developed a systematic typology on this basis. Systematic sociology was not the bent of her mind, and her culture pattern concept could not be sufficiently rigorously defined for comparative work of this kind. On the other hand, her imaginative insight and originality suggested a new field of problems for a younger generation of anthropologists and psychologists, and her literary gifts made her work available to the general public and very much influenced educationists. She must certainly be reckoned as one of the originators of the study of culture and personality which is such a dominant trend in American anthropology to-day.

Ruth Benedict was deeply interested in contemporary problems. During the War she used her methods and concepts to provide a study of the culture patterns of the Japanese for the American Office of War Information. At the time of her death she was engaged in a study of contemporary European cultures, and particularly of their methods of child education. She visited Europe during the past summer and was present at the International Ethnological Congress at Brussels, where she impressed her fellow workers by her vigour and charm. Her death in the middle of an important piece of work will certainly be deeply regretted by anthropologists everywhere.

AUDREY I. RICHARDS

Sir George Hill, K.C.B.

GEORGE FRANCIS HILL, numismatist, and director of the British Museum during 1931–36, youngest son of Samuel John Hill and grandson of Micaiah Hill, both missionaries in India, was born at Berhampur on December 22, 1867, and educated at Blackheath School, University College School, University College, London, and Merton College, Oxford, where he obtained first classes in Classical Moderations and Literæ Humaniores, and under the influence of Prof. Percy Gardner devoted himself to the study of Greek coins. He entered the British Museum in 1893, where Barclay Head had recently published his "Historia Numorum", still the standard text-book in that subject; and edited no less than six volumes of the "Catalogue of Greek Coins". The first of these, on the "Coins of Cyprus" (1897), was followed many years later by a general history of that island, the third volume of which, published in the present year,

brings the story to the Turkish conquest in 1571. Meanwhile, he did valuable service as editor of the *Journal of Hellenic Studies* and of the *Numismatic Chronicle*, edited a handbook of "Sources for Greek History", and extended his special studies to Italian coins and medals, and the practical art of die-engraving. His great "Corpus of Italian Medals before Cellini" is his monument in this field.

In 1931, Hill succeeded Sir Frederic Kenyon as director and principal librarian of the British Museum, for which he acquired the biblical "Codex Sinaiticus" from the Soviet Government, and the Eumorphopoulos collection of Oriental antiquities, and where he planted the almond trees in the forecourt. He was created K.C.B. in 1933 and retired in 1936. He took an active interest in the British Academy, the Society of Antiquaries, the Royal Commission on Historical Monuments, the Joint Archæological Committee, and the Hellenic and Numismatic Societies; and published a standard treatise on "Treasure Trove".

Hill died in London on October 18, while a memorial volume of the *Hellenic Journal* and a bibliography, compiled by his many friends, were still with the printers. JOHN L. MYRES

Mr. O. H. Latter

THE death of O. H. Latter on October 11 has removed not only a pioneer in science-teaching in schools but also one who, at the age of eighty-four, was as keen in sight and in mind and as ardent a correspondent as men sixty years his junior. His last letter in the *School Science Review*—characteristically both recalling a lecture of his Oxford days and insisting on accuracy to-day—appeared in June this year; and only two days before his death, while gardening, he shot one of his chief enemies, a grey squirrel.

Latter went as a boy to Charterhouse in 1878 and found there two science masters and no laboratory. In 1887 he took a first class in natural science at Oxford and became Berkeley fellow of Owens College, Manchester; he returned to Oxford in the following year as senior demonstrator to the Linacre professor. Next year he returned also to Keble as tutor. It was largely by chance—a very fortunate chance for science teaching—that in 1890 he returned to Charterhouse as senior science master. There he remained for thirty-six years, during ten of which he was a housemaster.

Latter's special interest was in Lepidoptera, Diptera and most particularly Hymenoptera. His paper in the *Cornhill* on wasps is typical of his gifts for observation and sympathetic exposition. But no branch of natural history escaped him. He contributed to various scientific journals papers on shell-fish, the rabbit, puss-moth, cuckoo's eggs, an odd contortion in dog's mercury, and as a 'holiday task' in his seventieth year (with H. Eltringham) on the scent mechanism of the male *Euploea*. No living thing seemed to him to have been so well studied that nothing new could be observed about it, as witness his papers on the breathing of tadpoles (1923) and the dispersal of burdock (1941).

But Latter was far more than an observer, a writer of broad and lucid text-books and a teacher, great as is the debt his pupils owe to him and continue to acknowledge. He was a founder of what was then the 'Public Schools' Science Masters' Association', and his profound belief in the value of science (and especially biology) as an essential, and not merely a vocational, element in education has had an influence far beyond the public schools. Addresses of his exist on this, his favourite, subject to the British Association, the Association of Preparatory Schoolmasters and the Rotary Club of Colombo; and apart from this wider appeal his public spirit made him for many years the most valued chairman of Godalming Higher Education and Corporation Museum Committees and of the governors of Godalming County School. Fifty-eight years of meteorological observations have ended with his passing: his immense contribution to education remains. J. C. THOMSON

WE regret to announce the following deaths:

Prof. Johan Hjort, For.Mem.R.S., known for his sea-fisheries investigations, on October 7, aged seventy-nine.

Prof. Gustave Roussy, *académicien libre* of the Paris Academy of Sciences, formerly rector of the Sorbonne and director of the Cancer Institute of the Faculty of Medicine, Paris, on September 30, aged seventy-three.

Dr. J. H. M. Wedderburn, F.R.S., professor of mathematics in Princeton University, aged sixty-six.

Dr. C. M. Wenyon, C.M.G., F.R.S., formerly director-in-chief, Wellcome Research Institution, on October 24.

NEWS and VIEWS

Dr. Lise Meitner

WHEN, on November 7, Dr. Lise Meitner celebrates her seventieth birthday, her many friends will offer her their warmest congratulations and respectful admiration on a life of great activity, during which she has maintained the highest reputation for experimental discoveries in radioactivity and nuclear physics. Dr. Meitner studied under Boltzmann in Vienna. Moving to Berlin, she was for a time '*Assistent*' to Planck. She then joined Otto Hahn and thus began a long and rich collaboration, ended only by her flight from the Nazi regime. Her investigations during this period of about thirty years are so many and so varied that only a few can be mentioned here. An early joint paper on the absorption of β-rays was followed by the discovery, with von Baeyer, of homogeneous groups in the β-ray emission from radioactive bodies. This opened up a new field, to which she returned again and again in subsequent years, taking a leading part in the elucidation of β- and γ-ray spectra and in the study of the properties of β- and γ-rays. To the earlier period of collaboration belongs also the discovery of protoactinium in 1918. In later years she worked with Hahn, and also with Strassmann, on the neutron-induced radioactivity of uranium. After Hahn and Strassmann had discovered the presence of active barium in irradiated uranium, and thereby established the division of the uranium nucleus, Dr. Meitner and her nephew O. R. Frisch gave, in a letter in *Nature* in March 1939, the first physical

picture of the fission process, introducing the term 'fission' and making an estimate of the energy liberation. Using the method of recoil, which she and Hahn had applied so effectively in the early days of radioactivity, she was later able to show that the bodies previously called 'transuranic' did, in fact, originate by fission. Since 1939, Dr. Meitner has worked in Stockholm, where she now directs a small but active laboratory. Enjoying good health and abundant energy she can, while looking back on a life full of high achievement, also look forward to further years of happiness and success.

Nobel Prize for Medicine : Dr. Paul Müller

THE award of the Nobel Prize for Medicine for 1948 has been made to Dr. Paul Müller for his discovery of the effects as an insecticide of D.D.T. Drs. P. Läuger, P. Müller and H. Martin were the leaders of an intensive research for insecticidal chemicals in the Basle laboratories of J. R. Geigy, S.A., which extended more than twenty years. The researches were directed originally towards the discovery of moth-proofing agents to be incorporated in fabrics. It was in the section of research entrusted to Paul Müller that D.D.T. was actually synthesized and its contact insecticidal properties discovered. It seems to have been in the course of field trials that its remarkable effectiveness against the Colorado beetle was noticed. It was soon found to be equally toxic to the louse and the mosquito. The material was brought to the notice of medical entomologists in Great Britain and the United States at a critical moment in the War when the supplies of pyrethrum were rapidly falling short of the demand. Soon it was being produced in very large quantities on both sides of the Atlantic. It proved of enormous value in combating typhus and malaria during the War, and now it is being employed with success in campaigns for the complete eradication of malaria from island areas. It is an equally valuable weapon in agricultural entomology and has provided a great stimulus to the search for yet other insecticides.

Dr. G. M. Vevers

DR. G. M. VEVERS, superintendent of the Zoological Society of London, will be retiring for medical reasons at the end of the year. He received his medical education at St. Thomas's Hospital, London, and served in the First World War as a captain in the R.A.M.C. After demobilization he became assistant to Prof. R. T. Leiper, in the Department of Helminthology of the London School of Tropical Medicine, and was awarded a Beit Medical Fellowship for Medical Research in parasitology. The same year he was also appointed honorary parasitologist to the Zoological Society and spent much of his time in the Society's prosectorium. In 1921 he went to British Guiana on a Colonial Office inquiry into filariasis. In 1923 Dr. Vevers was appointed superintendent of the Zoological Society in succession to the late R. I. Pocock. He introduced the application of the general principles of hygiene to wild animals in captivity, paying particular attention to the helminthic infections which used to be such a frequent cause of death in newly imported animals. He also introduced improvements in diet and housing, resulting in a reduction of the incidence of dietetic diseases and epidemics such as tuberculosis. He was also responsible for carrying out the extensive building programme at the Zoological Gardens, Regent's Park, following the First World War.

Dr. Vevers was closely associated with the late Sir Peter Chalmers Mitchell in the formation and development of Whipsnade Zoological Park, in which he took a very special interest. He also designed the layout of the Dudley Zoological Gardens, and since the Second World War has been engaged in the reconstruction and rehabilitation of the Zoo at Regent's Park. He is the author of numerous papers on helminthology and the keeping and breeding of animals in captivity ; also children's books and other books on general natural history, and has been a regular broadcaster in the B.B.C. Children's Hour and other programmes. He was elected an honorary fellow of the Royal College of Surgeons in 1946 ; and has been awarded the Silver Medal of the Zoological Society of London, and the Gold Medal of the Zoological Society of Glasgow and West of Scotland. After his retirement Dr. Vevers will continue to reside at Whipsnade, and will be available for consultation by the Society in an advisory capacity.

Botany at Rothamsted : Dr. Winifred E. Brenchley

ON her retirement from the post of head of the Botany Department, Rothamsted Experimental Station, on October 1, Dr. Winifred E. Brenchley had completed forty-two years of service there. She went to Rothamsted in 1906 as the holder of a Gilchrist Studentship of the University of London, and in the following year was appointed to the permanent staff. Dr. Brenchley was the first woman member of the staff, and it says much for her personality and for the quality of her work that the appointment was an immediate success and paved the way for many other women to undertake research in agricultural science at Rothamsted. Dr. Brenchley was a pioneer in the study of the effects of micronutrient elements on plant growth, and is an acknowledged authority in this field. Before the importance of elements such as boron, copper and manganese in plant nutrition was fully appreciated, she began a long series of solution-culture studies on elements other than the ten known to be essential. Her monograph "Inorganic Plant Poisons and Stimulants", published in 1914, described her own results and provided a valuable critical summary of the scattered information then existing on the subject. The investigation of the effects of boron made afterwards is perhaps the best-known work from her laboratory. Dr. Brenchley's other chief interests have been in the ecology of weeds, and in the changes with time in the flora of the permanent Park Grass plots at Rothamsted. The results of her earlier studies on these plots provided material for her book "Manuring of Grassland for Hay", published in 1924. Dr. Brenchley has played a very active part in the social life of Rothamsted, and in recognition of her long-continued interest in the welfare of all members of the staff, a presentation was made to her at a party held on October 22, attended by many of her past and present colleagues. Dr. Brenchley is to continue her research work at Rothamsted on a part-time basis. Her successor as head of the Botany Department is Dr. D. J. Watson, formerly in charge of the Crop Physiology Section, which has now been merged with the Botany Department.

Indian Archæology at the University of London

ON October 28, at the Institute of Archæology, London, Prof. K. deB. Codrington, the newly appointed professor of Indian archæology, gave an in-

augural lecture entitled "The Place of Archæology in Indian Studies". The High Commissioner for India, Mr. Krishna Menon, who took the chair, said that the creation of such a chair was very welcome and he hoped that it would lead to exchanges of scholars on both sides. He welcomed the appointment of Prof. Codrington, whose second home was India. In his lecture, Prof. Codrington stressed the educational value of the study of archæology, and the need of close collaboration between all who are interested in the study of India. Outlining the relations of the earliest city culture in India with north and south Persia, he went on to describe the intrusion of the neolithic tanged-adze culture of South-East Asia with reference to the first appearance of the Aryans in India. The chair of Indian archæology in the University of London is held jointly at the Institute of Archæology and the School of Oriental Studies.

Food and Agriculture Organisation

THE fourth annual conference of the Food and Agriculture Organisation of the United Nations will open in Washington on November 15. The conference will review the world food situation and the technical activities of the Food and Agriculture Organisation. It will also consider major constitutional, administrative and financial issues, particularly the budget for the next financial year. The United Kingdom delegation will be led by Mr. Tom Williams, Minister of Agriculture and Fisheries; the alternate leader is Mr. R. H. Franklin, deputy secretary in the Ministry of Agriculture and Fisheries. Among other members of the delegation will be Sir Ralph Enfield (chief economic adviser) and Mr. A. T. A. Dobson (fisheries adviser), both of the Ministry of Agriculture and Fisheries; Dr. N. C. Wright (chief scientific adviser), of the Ministry of Food; Sir Gerard Clauson, assistant under-secretary of State in the Colonial Office; Mr. P. N. R. Butcher, assistant secretary in the Ministry of Health; Mr. A. N. Duckham, agricultural attaché to the British Embassy; and Mr. G. R. Oake, head of the British Supply Office (Food) in Washington. In addition, Mr. James Turner, president of the National Farmers Union, and Mr. E. G. Gooch, president of the National Union of Agricultural Workers, will serve as advisers to the delegation.

Biological Service in Great Britain

MR. HERBERT MORRISON, Lord President of the Council, announced in the House of Commons on November 1 that Capt. Cyril Diver has been appointed head of the biological service which is to be formed for the conservation of the fauna and flora of Great Britain, including Nature reserves. The London office of the service is at Thorney House, Smith Square, S.W.1.

Society of Chemical Industry: Fine Chemicals Group

THE Fine Chemicals Group of the Society of Chemical Industry has for its objects "The discussion of fine chemicals especially such as are of therapeutic or biological interest". The Group held its inaugural meeting at the Royal Institution on October 5, with Sir Jack Drummond, chairman of the Group, presiding. Prof. J. H. Burn, professor of pharmacology, University of Oxford, delivered the inaugural address and reviewed much of the important work that has been done in the production of fine chemicals for medicinal use. He recalled the lapse of time between the discovery of penicillin in 1929 and its use in 1941, and suggested that, but for the recognition of the curative value of sulphonamides, it is possible that the use of penicillin might have been held up indefinitely owing to the false notion that "an antibacterial agent for use in man is an impossibility". Prof. Burn referred particularly to the work in the fields of tuberculosis and cancerous growths, of which the latter is still, in his opinion, the outstanding unsolved problem; it is one thing to deal with bacteria in the blood and extracellular fluid, but quite another thing when the bacterial agents are inside the cell or even in the nucleus. Much knowledge is to be gained from the classical work of Dale and Laidlaw with Carr, Barger and Ewins on adrenaline (and sympathomimetic amines), histamine and acetylcholine. It is increasingly obvious that the effect of chemical substances in the body is to modify or interfere with the action of these three compounds. This matter is of great importance in the study of anæsthetics, and it would be worth while to promote research in this direction. In the general problems of research, Prof. Burn felt that the university worker ought to pass on more of his knowledge to the industrial laboratories, and the industrial men of science must take 'refresher' courses in the academic laboratories to keep abreast of new techniques. The crying need of to-day is not for more fundamental knowledge but more application of the present existing knowledge. In conjunction with this, Prof. Burn expressed the opinion that the value of elaborating quantitative methods for the estimation of biological properties is indisputable. This work has been criticized as not leading to any fundamental discovery; but since 1926 chemical work has been much facilitated by the introduction of biological standards, and the Pharmaceutical Society has made a wise decision in establishing a laboratory for the study of biological standardization.

Cultural Geography of the Tarascan Area, Mexico

PUB. NO. 7 of the Institute of Social Anthropology, Smithsonian Institution, Washington, by Robert C. West, may be specially welcomed because it deals with a population in its environment in western Mexico, and takes note of physical features, climate, agriculture, handicrafts, houses and settlements and material culture generally. The geognostic map is an interesting key to the environment and so are the maps, admittedly based on inadequate data none too reliable, of climatic features, especially the frequency of frost on the highlands. Tarascan was an indigenous language of pre-Spanish days; the conquerors misused the natives in mines and elsewhere, missionaries and others 'hispanized' large numbers of the remainder on great *estancias* (stock-raising farms) and *haciendas* (crop farms); so the old language lingers only in the poorer areas which Europeans did not wish to occupy. The recession of Tarascan speech is traced in maps for different periods. Wheat and barley were cultivated soon after the Spanish Conquest in order to pay the tribute demanded by the authorities, and Arabic modes of irrigation also came in. Each community had owned surrounding lands in which the chief apportioned the right of user among the villagers. Since the mid-nineteenth century, individual ownership has developed; but vestiges remain, and in some pueblos a head-of-family may have 2–4 hectares allotted *sine die* provided he does not leave the land untilled for more than two successive years. He may sell his right-of-user, but only to another

member of the pueblo. The woodland is, at least in theory, communal property. The gradations from indigenous to more or less European tradition give pages of special interest to this book.

High-Vacuum Equipment

PARTICULARS have recently been received from Messrs. W. Edwards and Co. (London), Ltd., Kangley Bridge Road, London, S.E.26, of several new devices which they manufacture for use with pumps and vacuum equipment. These include controllable leaks for the continuous admission of small quantities of gas to a vacuum system. A dial allows any particular setting of the valve to be noted and repeated. The other equipment consists of various combinations of bellows and micro-switches to form pressure-controlled relays capable of operating a half-horse-power A.C. motor. One version can be used to switch off power supplies, or start a motor, when the pressure in a vacuum system reaches any predetermined value between 15 and 500 mm. of mercury. Another application is as a safety device which comes into play when the rate of flow of liquid in a tube falls outside chosen limits. This instrument is also supplied in a form which indicates the rate of flow on a dial. No doubt many applications of these units will be found in apparatus which has to run for long periods without attention.

Colonial Services: Recent Appointments

THE following appointments in the Colonial Services have been announced: J. S. Campbell, agricultural officer, Nigeria; H. D. Matheson, agricultural officer, Federation of Malaya; D. J. Parsons, agricultural officer, Uganda; J. B. D. Robinson, chemist, Department of Science and Agriculture, Barbados; J. W. F. Chapman, assistant conservator of forests, Nigeria; D. A. Francis, assistant conservator of forests, Gold Coast; F. W. Binge, geologist, Kenya; T. C. James, geologist, Tanganyika; D. L. Searle, geologist, Kenya; R. B. Smith, agricultural officer, Trinidad; M. E. R. Taylor, assistant conservator of forests, British Guiana; J. H. Wheelan, assistant conservator of forests, Gold Coast; H. Gillman (agricultural officer, Tanganyika), senior agricultural officer, Tanganyika; R. Johns (agricultural adviser to the comptroller of development and welfare, West Indies), deputy director of agriculture (regional), Nigeria; R. W. R. Miller (agricultural officer, Federation of Malaya), director of agriculture, Sarawak; A. Smith (rural education officer, Gold Coast), principal agricultural education officer, Gold Coast; F. E. Hughes (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast.

University of London

THE title of professor emeritus in the University of London has been conferred on the following: Sir Alexander Fleming, professor of bacteriology in St. Mary's Hospital Medical School since 1928; Sir Francis Fraser, professor of medicine and physician in St. Bartholomew's Hospital Medical College during 1920–34 and professor of medicine in the British Postgraduate Medical School during 1934–46; Prof. H. Gordon Jackson, professor of zoology in Birkbeck College since 1928, and master of the College; and Prof. C. H. Lobban, formerly head of the Department of Civil and Mechanical Engineering and professor of civil engineering in King's College during 1935–46.

The following doctorates have been conferred: D.Sc. on Elsie M. Widdowson (Imperial College); D.Sc.(Eng.) on Hugh Ford (Imperial College), H. C. H. Gurney and Harry Walker (external students).

Royal Society of Edinburgh: Officers for 1948–49

AT a statutory meeting of the Royal Society of Edinburgh, held on October 25, the following officers and members of council were elected: *President:* Sir William Wright Smith; *Vice-Presidents:* Prof. W. M. H. Greaves, Prof. James P. Kendall, Sir Ernest Wedderburn, Prof. A. C. Aitken, Prof. E. P. Cathcart, Sir Alexander Gray; *General Secretary:* Dr. J. E. Richey; *Secretaries to Ordinary Meetings:* Prof. E. T. Copson, Prof. Arthur Holmes; *Treasurer:* Mr. Andrew White Young; *Curator of Library and Museum:* Dr. John E. Mackenzie; *Ordinary Members of Council:* Prof. A. D. Hobson, Prof. W. O. Kermack, Dr. John Weir, Prof. J. H. Gaddum, Prof. G. D. Preston, Prof. S. J. Watson, Mr. R. Ll. Gwilt, Prof. J. N. Davidson, Mr. Edmund G. Dymond, Mr. Charles W. Parsons, Prof. R. W. Wheldon, Prof. E. M. Wright.

Institute for the Study of Animal Behaviour

AT the annual general meeting of the Institute for the Study of Animal Behaviour, held on October 10 in the rooms of the Linnean Society, Dr. W. H. Thorpe, of the Department of Zoology, Cambridge, was elected president in succession to Prof. Edward Hindle. Dr. Thorpe, who is a leading British worker in the field of animal behaviour, is a member of the editorial board of *Behaviour*, the new international journal devoted to this subject. Dr. P. H. T. Hartley, of the Edward Grey Institute, Oxford, was elected joint honorary secretary with Prof. Alastair N. Worden, while Mr. James Fisher, a former honorary secretary, was elected honorary treasurer. The following were elected to serve as members of Council: Mr. R. J. Bartlett (London), Dr. J. T. Edwards (London), Dr. John Hammond (Cambridge), Prof. A. C. Hardy (Oxford), Prof. Edward Hindle (London), Prof. Julian Huxley (Unesco), Dr. E. S. Russell (Hastings), Dr. Arthur Walton (Cambridge) and Dr. C. W. M. Whitty (Oxford).

Announcements

A DISCUSSION on "The Theory and Practice of New Techniques in Separation and Purification", to be held by the Chemical Society on November 25, has been arranged by Dr. R. P. Linstead. There will be two sessions: "Chromatography and Partition Chromatography", at 2.30; "Ion Exchange", at 7.

A COMPLIMENTARY dinner was given on October 22 to Prof. John Read by the members of the Chemical Society of the University of St. Andrews to mark the celebration of his silver jubilee as professor of chemistry in the University, to which he came in 1923 from the chair of organic chemistry at the University of Sydney. Mr. A. R. Battersby, president of the Society, presided over a representative gathering, which included Sir James Irvine, principal of the University and a former occupant of the chair of chemistry.

ERRATUM.—In *Nature* of October 30, p. 690, under "The Night Sky in November", line 8, for "easterly" read "westerly".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Life-Span of Red and White Blood Corpuscles of the Hen

In a former communication[1], a method of determining the life-cycle of nucleated erythrocytes was described. The method is based on the fact that radiophosphorus incorporated into desoxyribosenucleic acid molecules during the formation of the red corpuscles in the marrow of the hen remains in the erythrocytes throughout their life-time. If labelled sodium phosphate is administered repeatedly to a hen with the aim of keeping the plasma activity at a constant level, the specific activity of the desoxyribosenucleic acid phosphorus extracted from the erythrocytes is found to increase with time according to a linear curve and to reach the level of the specific activity of the inorganic phosphorus of the blood plasma after the lapse of 33 days. Thus, after that date, we find only such red corpuscles in the circulation as were formed during the experiment. As, according to these experiments, about five days elapse before the labelled corpuscles are released into the circulation, the life-span of the red corpuscles works out to be $33 - 5 = 28$ days.

An alternative method of the determination of the life-span of the red corpuscles is the following (cf. Shemin and Rittenberg's[2] experiments, in which glycine containing nitrogen-15 was administered). Phosphorus-32 is injected only at the start of the experiment. During the first day, when the activity-level of the marrow is very high, strongly active erythrocytes are formed. During the days after the injection, the activity of the plasma, and correspondingly that of the marrow, is rapidly declining, and the erythrocytes formed at later dates show a much smaller activity. The specific activity of desoxyribosenucleic acid phosphorus isolated from erythrocytes is nil during the first two days; but it rapidly increases during the fourth and even the fifth day after the injection. This indicates that the main part of the strongly active corpuscles is released into the circulation at that date. Later, the activity increases, but only slightly, as erythrocytes formed with smaller activity reach the circulation. This increase continues until the strongly active corpuscles formed during the first day of the experiment reach their life-span and are removed from the circulation. From this point onwards, the activity rapidly decreases so long as these cells are being broken down.

From the data obtained for the specific activities of plasma inorganic phosphorus and desoxyribosenucleic acid phosphorus of the corpuscles, and by making use of the considerations put forward by Shemin and Rittenberg[2], it is possible to calculate the percentage of the corpuscles present in the circulation which is formed during the first day of the experiment. (Details of such a calculation will be published shortly elsewhere.) Fig. 1 shows the results of an experiment aiming at the determination of the life-cycle of the red corpuscles. The horizontal part of the curve between 6 and 32 days indicates clearly that the number of labelled atoms, and hence the number of labelled corpuscles, present in the circulation does not change within that interval of time. The sudden decrease in the number of labelled

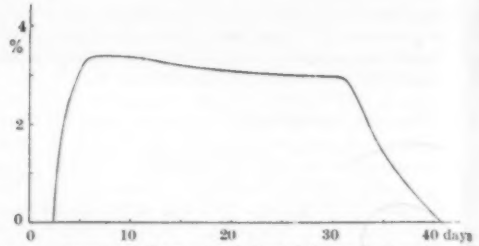


Fig. 1. Percentage of hen *red* cells formed during the first day of the experiment which is present in the blood stream at the time indicated on the *x*-axis

corpuscles at about 35 days is thus to be interpreted as due to the disappearance not of the labelled phosphorus atoms alone, but of the total corpuscles. In this experiment, the release of the labelled corpuscles into the circulation was found to take place after the lapse of three days, in contrast to five days in the first method described, mainly due to a more refined method of measurement. Correspondingly, the mean life-span of the erythrocytes is about $35 - 3 = 32$ days.

Though the white corpuscles are a mixture of different corpuscle types, it seemed to be of interest to determine the life-span of this mixture, making use of the second method. 60 μC. radioactive sodium phosphate was injected into a hen and blood samples were secured at suitable intervals. The leucocytes were isolated by the method of Butler and Cushman[3] and their desoxyribosenucleic acid phosphorus was extracted by Schmidt and Thannhauser's method[4]. The percentage of the white corpuscles formed during the first day and present in the circulation at subsequent dates is seen in Fig. 2. Should white corpuscles show a similar behaviour with respect to their life-cycle as do red corpuscles, we might expect the curve to have a horizontal part. This, however, is not the case. This fact is due partly to the inhomogeneity of the mixture of white corpuscles and partly to the comparatively short life-time of the corpuscles; furthermore, there is a large statistical variation in the life-times of single white corpuscles. The curve indicates that at the most 10 per cent of the white corpuscles have a life-span of more than eight days.

Objections may be raised to this explanation and one might be tempted to interpret the results obtained by assuming that the white corpuscles do not preserve their 'label', and that we are confronted not with a change in the number of labelled white corpuscles, but with a turnover phenomenon. This can be shown, however, not to be the case. It is found that if the formation of new white corpuscles is stopped by irradiating the hen with 2,000 r., and phosphorus-32 is then administered, no labelled desoxyribosenucleic

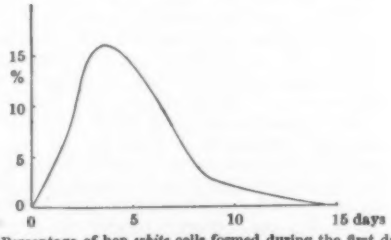


Fig. 2. Percentage of hen *white* cells formed during the first day of the experiment which is present in the blood stream at the time indicated on the *x*-axis

acid is formed in the leucocytes present in the circulation. This lack of formation of labelled nucleic acid can scarcely be a consequence of the effect of X-rays on the turnover rate, because a dose of 2,000 r. diminishes, but does not entirely stop, the renewal of desoxyribosenucleic acid in all types of tissue investigated[5]; it must be interpreted as a lack of formation of new white corpuscles. The turnover of desoxyribosenucleic acid present in the white corpuscles is thus negligible.

I wish to express my most cordial thanks to Prof. N. Bohr for numerous facilities put at my disposal, and to Prof. G. Hevesy for his kind interest and many helpful suggestions throughout the work.

J. Ottesen

Institute for Theoretical Physics,
University, Copenhagen.

[1] Hevesy, G., and Ottesen, J., *Nature*, **156**, 534 (1945).
[2] Shemin, D., and Rittenberg, D., *J. Biol. Chem.*, **166**, 627 (1946).
[3] Butler, A. M., and Cushman, M., *J. Clin. Invest.*, **19**, 459 (1940).
[4] Schmidt, G., and Thannhauser, S. J., *J. Biol. Chem.*, **161**, 83 (1945).
[5] Hevesy, G., *Rev. Mod. Phys.*, **17**, 102 (1945).

Introduction of Radioactive Tracers into Antisera

It has been found possible to introduce radioiodine into the globulin molecule of an antiserum without seriously impairing the agglutinating power of the serum.

The globulin fraction of a *Proteus vulgaris* rabbit antiserum was prepared by two successive precipitations with a 22 per cent concentration of sodium sulphate, and dissolved in $M/15$ phosphate buffer of *p*H 7. It was then treated with an aqueous iodine solution (0·1 mgm/ml.) containing also some 8-day radioiodine. Reaction is complete in a few minutes, approximately 20 per cent of the iodine being substituted into the globulin. The remainder, now present as iodide, was removed by dialysis.

A solution containing 5 mgm. of the iodinated antiserum globulin in 70 ml. of *p*H 7 phosphate buffer was mixed with 5 ml. of normal serum and sufficient *Proteus* suspension to remove all the agglutinins. After standing for one hour at 56° C., the agglutinated bacteria were filtered out, washed, and their radioactivity determined. The accompanying table is typical of the results obtained.

Iodine atoms (n) per antiserum globulin molecule (mean), assuming mol. wt. globulin 156,000	Percentage of total activity precipitated
1·0	8·1
2·3	8·1
3·1	9·3
7·7	5·7

A control experiment with normal rabbit globulin gave only about one per cent of precipitable activity, which may have been due to naturally occurring agglutinins in the serum.

With increase of the iodine content above 10 atoms per molecule, the agglutinating titre and percentage of precipitable activity of the globulin showed a marked decrease. The iodine probably becomes substituted into the tyrosine residues, of which there are about 58 per molecule.

If the number of iodine atoms, n, as defined in the above table is small compared with 58, the probability of a globulin molecule containing m iodine atoms will be:

$$\frac{n^m}{m!} \cdot \exp - n.$$

Consequently, for $n = 1$, 36·8 per cent of the globulin molecules will contain no iodine; but for $n = 7{\cdot}7$, only 0·05 per cent will contain no iodine. Since, however, over this range of n the agglutinating titre showed little alteration, it follows that slightly iodinated antiserum globulin has substantially the same agglutinating properties as the untreated antiserum globulin.

It should be possible to use this technique for the standardization of a considerable variety of antisera.

I wish to thank Drs. R. F. Menzies and H. Bensted, who prepared the antisera. Acknowledgment is made to the Director, Atomic Energy Research Establishment, for permission to publish these results.

F. D. S. Butement

Atomic Energy Research Establishment,
Harwell, Didcot,
Berks.
June 1.

Succinic Acid in the Blood of the Larva of *Gastrophilus intestinalis*

During the course of biochemical investigations on the parasitic larvæ of the fly *Gastrophilus intestinalis*, advantage was taken of the ease with which the hæmoglobin-containing 'tracheal organ' cells[1] and the hæmolymph which surrounds them could be obtained in order to study the interrelationship between the two *in vitro*. For this purpose an investigation of the respiratory metabolism of the tracheal organ was undertaken, employing standard manometric methods.

The oxygen uptake of tracheal cells in either phosphate buffer or a specially prepared '*Gastrophilus* Ringer' solution was small; but it was increased up to nine times in presence of the insect's own hæmolymph. Analyses of fructose, glucose, lactate, pyruvate, citrate and succinate having been made on the blood[2,3], the effect of these substances, and of fumarate and butyrate, on the oxygen consumption of the tracheal cells suspended in phosphate buffer was determined. Only with succinate was there an increase in oxygen uptake comparable with that found when the hæmolymph was the suspension medium. Evidence that the factor present in the hæmolymph responsible for this increase is indeed succinate was obtained as follows.

Preliminary experiments showed that the active material was dialysable and could be extracted by ether at an acid *p*H. Accordingly, the blood from some 1,200 third-instar *Gastrophilus* larvæ was dialysed against three changes of distilled water. The combined external fluid was acidified to *p*H 2, reduced in bulk by evaporation to 50 c.c., and continuously extracted with ether for ten hours. At this stage the aqueous phase was devoid of activity when tested with tracheal organ cells. The ether extract was then itself extracted three times with equal volumes of water, and the combined aqueous extract washed with a quarter of its volume of ether to remove easily ether-soluble substances. The aqueous solution was now evaporated to dryness, the

solid residue taken up in 150 c.c. of ether and evaporated down to 5 c.c. The resulting crystals were filtered off, washed with ether and dried *in vacuo*. The yield was about 400 mgm. The crystals were monoclinic, and had a melting point (uncorrected) of 186–190° (m.p. of succinic acid, 184°). The silver salt of the acid, prepared according to Mrs. Needham's method[4], contained 62 per cent silver (theoretical : 65 per cent). When tested manometrically with a succinoxidase preparation from either pig heart or tracheal cells, the crystalline material was shown to be 91 per cent pure succinic acid.

By the same method succinate was also determined in *Gastrophilus* hæmolymph after deproteinization and ether extraction. The concentration varied from 128 to 404 mgm. per cent. The amount is already high in the half-grown second instar (the earliest stage at which it is practicable to collect hæmolymph), and appears to increase just prior to the second moult, to be followed by a decrease in the early third instar. These changes are summarized below.

Half-grown 2nd instar	2nd instar just prior to moulting	Early 3rd instar	Fully grown 3rd instar
279 mgm. %	351 mgm. %	203 mgm. %	242 mgm. %

To test whether succinic acid might have been formed during dialysis by continuous breakdown—enzymatic or otherwise—from some precursor, the hæmolymph was collected directly into 10 per cent metaphosphoric acid and the silver salt prepared. The yield from some 100 c.c. of blood was 230 mgm. of succinic acid, which shows that succinate is a normal constituent of the blood and not a breakdown product.

Pryor, Russell and Todd[5] reported that succinic acid was obtained from *Lucilia* pupæ, and this suggests that high concentrations of succinate may also be found in other species of insects. At present, however, any indication as to the origin or function of the succinate in the blood must await further study.

We should like to thank Prof. D. Keilin for suggesting this line of work, for his continued interest and advice, and the Agricultural Research Council for a research grant to one of us (L. L.).

L. Levenbook
Y. L. Wang

Molteno Institute,
University of Cambridge.
May 27.

[1] Keilin, D., and Wang, Y. L., *Biochem. J.*, **40**, 855 (1946).
[2] Levenbook, L., *Nature*, **160**, 465 (1947).
[3] Levenbook, L. (unpublished data).
[4] Needham, D. M., *Biochem. J.*, **18**, 351 (1924).
[5] Pryor, M. G. M., Russell, P. B., and Todd, A. R., *Nature*, **159**, 399 (1947).

Staphylococcal Coagulation and Fibrinolysis

Smith and Hale[1] were the first to point out that coagulation by staphylococci takes place in two stages. First, the bacterial product is converted to a thrombin-like agent by an activator substance found in plasma. This thrombin-like agent then produces fibrin. Gerheim, Ferguson and Travis[2], and Kaplan and Spink[3] have pointed out that the activator substance is associated with the albumin fraction in ammonium sulphate fractionation, while the latter workers showed that in alcoholic fractionation the activator appears to be associated with the alpha and beta globulins. Kaplan and Spink also have made an important contribution in their studies on the inhibition of the staphylocoagulase reaction.

Staphylococcal fibrinolysis in the past has either been ignored or explained on the basis that staphylocoagulase is a proteolytic ferment[4]. Lack[5], working in Britain, and Gerheim *et al.*[6,7] in the United States, have shown that staphylococcal coagulation and fibrinolysis are distinct phenomena. They are in agreement that staphylococci produce a kinase for the proenzyme, plasminogen (profibrinolysin), just as streptococci do. This kinase has been designated staphylokinase.

Gerheim *et al.*[7], in a series of heat-lability studies, have shown that heating for two hours at 75° C. completely destroys the coagulation precursor (prostaphylocoagulase), while there is little change in the staphylokinase reactivity.

Earl B. Gerheim

Department of Physiology,
University of North Carolina.
June 2.

[1] Smith, W., and Hale, J. H., *Brit. J. Exp. Path.*, **25**, 101 (1944).
[2] Gerheim, E. B., Ferguson, J. H., and Travis, B. L., *Proc. Soc. Exp. Biol. and Med.*, **66**, 525 (1947).
[3] Kaplan, M. H., and Spink, W. W., *Blood*, **3**, 573 (1948).
[4] Fredericq, P., *Acta Biochem.*, **5**, 1 (1946).
[5] Lack, C. H., *Nature*, **161**, 559 (1948).
[6] Gerheim, E. B., Ferguson, J. H., and Travis, B. L., *Fed. Proc.*, **7**, 41 (1948).
[7] Gerheim, E. B., Ferguson, J. H., Travis, B. L., Johnston, C. L., and Boyles, P. W., *Proc. Soc. Exp. Biol. and Med.* (in the press).

Excretion of D-Pyrrolidone Carboxylic Acid by Rat and Dog Fed with Tumour Proteins

There has been much controversy about our claim[1] that D-glutamic acid is a constituent of tumour proteins. Many authors were unable to confirm our results, and in their opinion the D-form which we isolated from malignant tumours was formed by partial racemization *in vitro* during the hydrolysis with hydrochloric acid. An explanation of these contradictory results will be given in future publications. Here we wish to record further evidence for the correctness of our views.

In 1940 we reported[2] that the normal dog was unable to digest rabbit tumours (Brown–Pearce) in the same way as common meat. The Neuberg[3] precipitate of the urine contained a peptide fraction which on hydrolysis yielded glutamic acid with 17 per cent D-form. From the peptide fractions of the fæces we isolated glutamic acid with 53 and 57 per cent D-form respectively, that is, with a surplus of the unusual antipode. So far as we know, these experiments have never been repeated in other laboratories. In connexion with some new facts mentioned below, it was desirable to repeat the experiments in our laboratory for a third time. A dog was fed for four days with cooked rat tumours (benzpyrene). The isolation of the peptide fraction of the fæces was carried out in the same way as described previously. In the new case the isolated glutamic acid contained 33 per cent D-form ; the lower value is in good agreement with our general experience that the rat tumours (benzpyrene) produce on acid hydrolysis only about half as much D-glutamic acid as the very malignant Brown–Pearce tumours.

In 1944, S. Ratner[4] reported the isolation of optically pure D-pyrrolidone carboxylic acid from the urine of rats after feeding a normal stock diet with the addition of DL-glutamic acid. The conversion is probably enzymatic. It seemed to us that, in our feeding experiments with tumour proteins, a part of the D-glutamic acid might have been split off and converted to D-pyrrolidone carboxylic acid. As this cyclic derivative is not precipitated by Neuberg's reagent, we would not have found it in our earlier experiments. The collected urine of the dog was adjusted to *p*H 2 (with sulphuric acid), filtered and continuously extracted for forty-eight hours with ethyl acetate, the temperature of the aqueous layer being 15° C. throughout this period. The oily residue obtained after the evaporation of the ethyl acetate was treated in the same manner as described by S. Ratner[4]. We finally obtained a colourless crystalline product which was identified by the melting point (alone and in mixture), the optical rotation ($[\alpha]_D = + 11{\cdot}2°$) and the analyses as the pure D-form of pyrrolidone carboxylic acid. We estimate that about 10 per cent of the D-glutamic acid of the tumour originally present is excreted in this way.

As a control, the same dog was fed with beef and the urine extracted with ethyl acetate. In this case deuterio-D-pyrrolidone carboxylic acid (5·30 atomic per cent deuterium) was added to the extract. The recovered tracer substance showed no depression of the isotope contents. This is in complete agreement with the results of S. Ratner[4]; further, D. Shemin and D. Rittenberg[5] demonstrated, with deuterium and nitrogen-15 as tracers, that no D-glutamic acid is formed in the organism of the vitamin B_2-deficient rat, a conclusion which is reasonably applied also to the normal animal.

In another experiment, tumour proteins of rats (benzpyrene) were fed to normal male rats. Here again we isolated D-pyrrolidone carboxylic acid from the urine; in this case the final purification was carried out by chromatographic fractionation (Al_2O_3 Brockmann II–III; alcohol as solvent). The optical purity of the cyclic compound was demonstrated by the conversion to D-glutamic acid ($[\alpha]_D = - 31{\cdot}5°$).

The excretion of an optically pure derivative of D-glutamic acid after the enzymatic 'digestion' of tumour proteins is not compatible with the current view that the D-form which we isolate after acid hydrolysis of tumour proteins is an artefact. Moreover, an important consequence for future experiments may be pointed out. We know from experiments, mainly unpublished, with labelled amino-acids that a small part of fed or injected D-glutamic acid is incorporated in the tumour proteins. If the labelled molecules of D-glutamic acid are displacing the 'intrinsic' ones, a decrease of the isotope content of the excreted D-pyrrolidone carboxylic acid should be demonstrable. However, it is not yet clear whether the 'extrinsic' D-glutamic acid is really displacing intrinsic D-glutamic acid, or whether it is being additionally incorporated. Another premise is a favourable ratio between the 'extrinsic' and the 'intrinsic' D-glutamic acid. In any event, the effect will be rather small, and its demonstration will depend upon a very accurate isotope determination. Preliminary experiments with deuterio-D-glutamic acid emphasize the importance of these points. Presumably the use of radioactive D-glutamic acid would be more suitable; we hope to carry out a crucial experiment as soon as possible.

Further details of the investigations will be published elsewhere. Grateful acknowledgment is made to the Rockefeller Foundation for the support of our work.

F. Kögl
T. J. Barendregt
A. J. Klein

Organisch-chemisch Laboratorium
der Rijksuniversiteit,
Utrecht.
June 17.

[1] Kögl, F., and Erxleben, H., *Z. physiol. Chem.*, **258**, 57 (1939) (1 Mitteilung). Kögl, F., Erxleben, H., and van Veersen, G. J., *ibid.*, **277**, 251 (1943) (9 Mitteilung).
[2] Kögl, F., and Erxleben, H., *Z. physiol. Chem.*, **264**, 108 (1940) (5 Mitteilung).
[3] Neuberg, C., and Kerb, J., *Biochem. Z.*, **40**, 498 (1912); **67**, 119 (1914).
[4] Ratner, S., *J. Biol. Chem.*, **153**, iii, 559 (1944).
[5] Shemin, D., and Rittenberg, D., *J. Biol. Chem.*, **151**, 507 (1943).

Bacteriostatic Action of Oximes

The action of numerous inorganic and organic substances on the growth of bacteria has been investigated in the hope of demonstrating properties useful either in the laboratory for selective and enrichment methods for isolation, or clinically for the treatment of the diseases which they cause. Record has not been found in bacteriological literature of the use of oximes in such an investigation.

The oximes and their derivatives used in the experiments described were kindly supplied by Dr. O. L. Brady, of University College, London. They included acetoxime, benzantialdoxime, N-methyl benzaldoxime, O-methyl benzaldoxime, salicyl-aldoxime and hydroxylamine hydrochloride. Each of these was tested against *Staphylococcus aureus*, β-hæmolytic streptococcus (Lancefield Group *A*), *Salmonella typhi*, *Bacterium coli*, *Proteus vulgaris* and *B. subtilis*.

Methods. For each test a series of nutrient agar plates was prepared, each plate containing a different concentration of the chemical to be tested. The concentrations were 1 : 400, 1 : 600, falling by 200 to 1 : 20,000. Suspensions in peptone water were made from well-grown 24-hr. agar cultures of the organisms. Small loopfuls of each suspension were inoculated on to the series of plates as well as on to control plates containing no oxime or derivative. After aerobic incubation at 37° C., readings of the amount of growth were taken at the end of 24 and 48 hours. In cases where all the organisms grew freely at the highest concentration of the compound, the experiments were repeated with still higher concentrations, namely, 1 : 100, 1 : 200 and 1 : 300.

Results. Acetoxime at the concentration of 1 : 400 failed to inhibit the growth of any of the organisms. It was afterwards found that the staphylococci were inhibited at 1 : 300, the β-hæmolytic streptococci at 1 : 200, and *B. subtilis* at 1 : 100. *Salm. typhi*, *Bact. coli* and *Proteus* all grew freely at 1 : 100. For the sake of brevity, the results with the other compounds are tabulated. The figures indicate the lowest concentration inhibiting the various test organisms.

Discussion. It will be observed that there is no outstanding difference in resistance or susceptibility among the different organisms tested. The hope of discovering a compound which would inhibit *B. subtilis* or prevent the swarming of *Proteus*, and yet not interfere with the free growth of organisms the

	Staph. aureus	*β Hæm. strept*	*Salm. typhi*	*Bact. coli*	*Proteus*	*B. subtilis*
Benzantialdoxime	1,200	1,200	1,200	800	600	800
N-methylbenzaldoxime	800	2,000	1,600	1,200	800	800
O-methylbenzaldoxime	800	2,000	1,200	600	800	1,200
Salicylaldoxime	2,000	4,000	2,000	1,200	1,200	1,200
Hydroxylamine hydrochloride	12,000	8,000	8,000	8,000	8,000	12,000

isolation of which was desired, was not fulfilled, as the *B. subtilis* and the *Proteus* were among the more resistant organisms. Similarly, such organisms as the β-hæmolytic streptococci and the *Salm. typhi*, the abundant growth of which is desired for their isolation and subsequent study, were among the most susceptible. The lack of marked resistance of *B. subtilis* compared with that of *Bact. coli* and *Proteus* is not unexpected, as the experiments measured the bacteriostatic and not bactericidal effect of the substances.

J. D. Allan Gray
R. A. Lambert
Central Middlesex County Hospital,
Park Royal, N.W.10.
June 3.

Aluminium Phosphate as Precipitant of Agglutinable and Non-Agglutinable Strains of *H. pertussis*

Alumina (hydrated aluminium oxide) is generally used to precipitate *H. pertussis* organisms from aqueous suspensions. With this adsorbent the preparation of alum-precipitated vaccines has never involved any difficulty in getting all the bacteria precipitated.

Some months ago a number of experimental vaccines were prepared with aluminium phosphate as precipitant. We noticed that a few *pertussis* strains were incompletely precipitated; this was unusual, having never occurred with alumina, and we thought it worth while to investigate the difference in behaviour of the various strains.

The strains were subjected to the customary test for agglutinability, using a phase I immune rabbit serum. It was found that the strains which had become incompletely precipitable with aluminium phosphate had also lost their ability to be agglutinated by the immune serum. To elucidate this phenomenon further, an examination was made of the twelve strains kept as stock cultures in our laboratories, and of a further thirty-three strains, freshly isolated from whooping-cough cases and kindly supplied to us by Dr. R. Cruickshank, of the Central Public Health Laboratory, Colindale. All strains were tested for agglutinability, using a formol-killed suspension prepared from each at a concentration of 2,000 million organisms per ml. Precipitability with aluminium phosphate was tested by adding 0·3 ml. of 5 per cent solution of disodium phosphate and 1 ml. of a solution of 2 per cent potash alum to 4 ml. of bacterial suspension at a concentration of 20,000 million organisms per ml. This is approximately twice the minimum amount of aluminium phosphate needed completely to precipitate the average precipitable strain. An estimate of the proportion of organisms precipitated was made by opacity measurements of the supernatant fluid about thirty minutes after the flocculles had begun to deposit.

The results are summarized in the accompanying table, which demonstrates that freshly isolated strains of *H. pertussis*, as well as old laboratory cultures having a satisfactory agglutination titre, were all completely precipitated with aluminium phosphate. Stained preparations of the suspensions of the two types of strains were examined under the microscope, and it appears that the non-agglutinable were shorter and smaller than the agglutinable strains. Stained with Giemsa, the former were rather basophil; but no morphological difference could be demonstrated.

Number of strains and origin

	5 laboratory stock cultures	7 laboratory stock cultures	33 Colindale
Agglutination titre	Less than 1 : 1,000	1 : 12,000 1 : 16,000	1 : 8,000 1 : 30,000
Behaviour with phosphate	Not precipitated	Completely precipitated	Completely precipitated

Various species of bacteria other than *H. pertussis* were tested for their precipitability with aluminium phosphate. It was found that the Gram-positive cocci (*Staph. aureus*, *Strept. hæmolyticus* and *pneumococcus*) are completely precipitated, as also is *C. diphtheriæ* (7 strains): *Ps. pyocyanea* and *Klebsiella pneumoniæ* were not precipitated, nor was *B. coli* or *B. paracolon*. Some strains of the *B. typhosum-paratyphosum* group were precipitated and some were not. The agglutinability of the strains could not be correlated with their precipitability. Three strains of *H. parapertussis* were found to be invariably precipitated: they could not be rendered non-agglutinable by *parapertussis* immune serum, despite repeated sub-culture (over two years).

H. pertussis suspensions stored after addition of phenol or ethyl alcohol slowly lose their agglutinability. It was found, however, that organisms rendered non-agglutinable by this means were still completely precipitated by aluminium phosphate. Moreover, we observed that agglutinable organisms after aluminium phosphate precipitation retain completely their ability to adsorb agglutinins from an immune serum.

Other adsorbents were studied, and we have found that cadmium phosphate behaves in the same manner as aluminium phosphate, whereas crystalline magnesium ammonium phosphate, although a relatively poor adsorbent, does adsorb agglutinable suspensions more readily. Acriflavine (1/2,000) precipitates all suspensions irrespective of agglutinability.

A *p*H optimum at which the organisms were most readily precipitated, analogous to an isoelectric point, was not found; agglutinable organisms were precipitated with equal facility over the *p*H range 4·0–10·0. At *p*H values below 4·0 precipitation does not take place, owing to solution of the adsorbent. Non-agglutinable organisms are not precipitated at any *p*H between 4·0 and 10·0.

Further indications that the two types of organism differ in surface properties were given by the finding that the agglutinable organisms are completely soluble in 0·2 *N* sodium hydroxide, or in 2 per cent solution of sodium desoxycholate, whereas non-agglutinable organisms are unaffected. There would appear to be an analogy with the bile-soluble organ-

isms of the *Streptococcus* group (pneumococcus), which have an antigenically active surface polysaccharide.

Agglutinability and precipitability of the two types of *pertussis* organisms were not influenced by treatment with salivary amylase or urinary diastase, and Molisch's test was positive for both types of suspension. Work on the relation between the biological properties of *H. pertussis* strains (agglutinability by immune serum, virulence to laboratory animals, endotoxin production, growth requirements on semi-synthetic media) and physical behaviour towards precipitants and solubilizing agents shows a close parallelism: it is hoped to publish our findings in fuller detail elsewhere.

J. UNGAR
P. MUGGLETON

Research Division,
Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
June 1.

N. Acridyl-(5)-Alanines as Antibacterial Substances

THE occurrence of D amino-acids in several antibiotic polypeptides has stimulated interest in the correlation between the optical form of amino-acids and their effect on the antibacterial activity of certain molecules[1,2]. In furtherance of the investigation previously reported by Linnell and Smith[3], the synthesis and resolution of the ethyl ester of DL-*N*. acridyl-(5)-alanine has been accomplished.

Condensation of DL-alanine with 5-chloroacridine in phenol solution gave a 96 per cent yield of DL-*N*. acridyl-(5)-alanine as a yellow powder, m.p. 214° (found: C, 70·7; H, 5·48; N, 10·7; theory: C, 72·1; H, 5·26; N, 10·52 per cent). The monohydrate of this acid had been prepared, in 80 per cent yield, by the condensation of alanine and 5-methoxyacridine[4]. The acetate, hydrochloride and sodium salt of the above compound were prepared under anhydrous conditions; but bacteriological testing at this stage was not possible because the free acid was practically insoluble in water and aqueous solutions of the salts rapidly hydrolysed to the parent acid. A similar result has been reported for *N*. acridyl-(5)-glycine by Dupré and Robinson[5].

Esterification with ethyl alcohol in the presence of dry hydrochloric acid gas gave an 80 per cent yield of the racemic ester. This crystallized from aqueous alcohol as small yellow prisms, m.p. 75° (found: N, 9·25; H, 6·26; theory: N, 9·52; H, 6·12 per cent). The ester gave well-defined crystalline compounds with picric and picrolonic acids, and its diacetate and monohydrochloride were quite stable in aqueous media. A preliminary test showed that a 0·1 per cent aqueous solution of the diacetate possessed antibacterial activity against *Staphylococcus aureus* and *Streptococcus pyogenes*.

Resolution of the racemic ester was achieved by the use of (+) tartaric acid. An 87 per cent yield of the racemic ester (+) bitartrate was obtained by mixing hot absolute alcohol solutions containing equivalent quantities of the ester and (+) tartaric acid. This salt was a deep yellow powder, m.p. 165°, $[\alpha]_D^{20} = +18°$ (water, $C = 4·0$). Fractional crystallization from 80 per cent alcohol gave the (+) ester (+) tartrate as long yellow needles, m.p. 118°, $[\alpha]_D^{20} = +54·5°$ (water, $C = 4·0$). Evaporation of the mother liquors and repeated crystallization of the residue from absolute alcohol gave the (−) ester (+) tartrate as a yellow powder, $[\alpha]_D^{20} = -19·5°$ (water, $C = 4·0$).

The ester isomers were isolated by extracting aqueous solutions of their respective (+) tartrates, which had been made alkaline with ammonia, with benzene. They were obtained as viscous yellow oils, (+) *N*. acridyl-(5)-alanine ethyl ester, $[\alpha]_D^{20} = +128°$ (96 per cent alcohol, $C = 2$); (−) *N*. acridyl-(5)-alanine ethyl ester, $[\alpha]_D^{20} = -122°$ (96 per cent alcohol, $C = 2$).

Preliminary bacteriological tests on aqueous solutions of the (+) tartrate showed that these salts caused inhibition of growth in the following dilutions.

Organism	Racemic ester (+) bitartrate	(+) ester (+) tartrate	(−) ester (+) tartrate
(1) *Staphylococcus aureus*	1/6000	1/6000	1/3000
(2) *Streptococcus pyogenes*	1/4000	1/4000	<1/2000

A fuller account of this work is to be published elsewhere. The preparation and resolution of DL-β acridyl-(5)-alanine is now being investigated, and it is proposed to include other amino-acids in later work.

W. H. LINNELL
M. J. H. SMITH

Research Laboratories,
Chemistry Department,
College of the Pharmaceutical Society,
17 Bloomsbury Square,
London, W.C.1.
July 12.

[1] Work, T. S., *Biochem. Soc. Symposia*, **1**, 61 (1948).
[2] Harris, J. I., and Work, T. S., *Nature*, **161**, 804 (1948).
[3] Linnell, W. H., and Smith, M. J. H., *Quart. J. Pharm. Pharmacol.*, **21**, 121 (1948).
[4] Barber, H. J., Wilkinson, J. H., and Edwards, W. G. H., *J. Soc. Chem. Ind.*, **66**, 414 (1947).
[5] Dupré, D. J., and Robinson, F. A., *J. Chem. Soc.*, 549 (1945).

Genetic Transmission of Two Rare Blood-Group Genes

To date no data of families have been published which illustrate the genetic transmission of the rare gene r^y, and only but one or two families which illustrate the transmission of gene R^z.

Recently, four families were encountered which illustrate the genetic transmission of the genes r^y and R^z in striking fashion. Because of the rarity of such cases, it seems important to record them, and they are listed in the accompanying table.

Families illustrating genetic transmission of the rare genes R^z and r^y

Case number		Parents		Children		
		Father	Mother			
1	Phenotype	Rh_1Rh_2	rh	rh	Rh_1Rh_2	Rh_1Rh_2
	Genotype	R^zr	rr	rr	R^zr	R^zr
2	Phenotype	rh′rh″	rh	rh	rh′rh″	
	Genotype	r^yr	rr	rr	r^yr	
3	Phenotype	Rh_1Rh_2	rh	Rh_1Rh_2		
	Genotype	R^zr	rr	R^zr		
4	Phenotype	Rh_1Rh_2	rh	Rh_1rh	Rh_1Rh_2	
	Genotype	$R\ R^1$	rr	R^1r	R^zr	

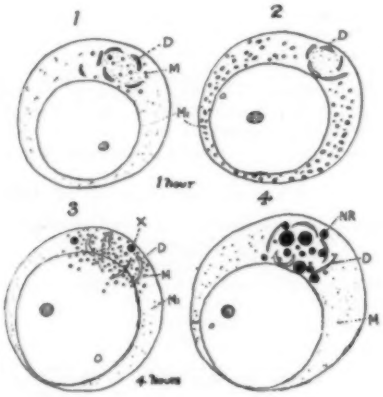
Incidentally, these more complicated cases serve to underline the importance of avoiding ambiguity between the designations for the phenotypes and genotypes.

A. S. WIENER

64 Rutland Road,
Brooklyn, N.Y.
Sept. 27.

Methylene Blue as a Vital Stain for the Golgi Apparatus

EXPERIMENTS have been made with five specimens of methylene blue as a vital stain for the spermatocytes of *Helix aspersa*. The specimens were an old German 'polychrome methylene blue', and four others, 'pure methylene blue', and just 'methylene blue'.



In a suitable concentration all the specimens acted in the same way, being segregated into small droplets (*M*) inside and outside the Golgi apparatus (*D*), neither the mitochondria, M_1, nor the lenticular dictyosomes staining (Fig. 1). At a higher concentration of the dye (not the polychrome methylene blue) the mitochondria stained intensely, rivalling the best Janus green vitally stained cells (Fig. 2). In many of these cases the methylene blue granules associated with the Golgi apparatus (Fig. 1) did not appear. The polychrome methylene blue at these higher, perhaps lethal, concentrations tended to stain the mitochondria blue and rarely the dictyosomes of the Golgi apparatus a reddish colour. The main difference between methylene blue and neutral red as vital dyes for *Helix* spermatocytes is that the methylene blue can be made to stain mitochondria or to segregate into droplets in the region of the Golgi apparatus, whereas neutral red does not stain the mitochondria or Golgi dictyosomes, but easily segregates into droplets which grow in size according to the length of time the cells are exposed to the dye. In Fig. 3 is a cell which has been exposed to a weak methylene blue solution for four hours. The number of methylene blue segregation artefacts has increased very greatly, the dictyosomes are still unstained and in rare cases the methylene blue segregation cavities may be large (*X*). Generally speaking, these cavities do not become as large as the neutral red artefacts (Fig. 4, after four hours).

It is interesting to note that the methylene blue segregation artefacts shown in Fig. 3 are spread both inside and well outside the region of the Golgi apparatus. In more highly differentiated cells, such as nerve or salivary cells, the behaviour of the methylene blue dye will be more complicated.

It is hoped to publish the results of these and other experiments on methylene blue and Sudan Black B elsewhere in a fuller form.

J. BRONTË GATENBY
TOHAMY A. A. MOUSSA

Department of Zoology and
Comparative Anatomy,
Trinity College,
Dublin.

REFERENCES
Parat, M., *Arch. Anat. Micr.*, **24** (1928).
Douglas, Duthie, Gatenby, *Z. wiss. Zool.*, **144** (1933).
Brown, R. H., *Quart. J. Mic. Sci.*, **79** (1936).
Baker, J., *Quart. J. Mic. Sci.*, **85** (1944).
Worley, L. G., *J. Morph.*, **75** (1944).
Karpova, *Z. Zellf. u. Mikr. Anat.*, **2** B (1925).

Passage of Hæmoglobin from Blood into Eggs of *Daphnia*

IT is known that the amount of hæmoglobin dissolved in the blood of *Daphnia* varies inversely with the oxygen content of the water in which the animals live. The changes in concentration of the hæmoglobin have been studied by a quantitative method which allows measurements to be made on a single *Daphnia*: the colour of the animal's blood is compared under the microscope with known dilutions of human blood[1]. In the course of further work involving the use of this method it was noticed that parthenogenetic females with eggs in the brood pouch have less hæmoglobin in their blood than those with embryos in the pouch. The difference is greatest in populations producing numerous young.

The parthenogenetic eggs of *Daphnia* contain hæmoglobin[2]. It can be seen under the microscope with reflected light that the ovaries become progressively pinker as they enlarge during the last few hours preceding egg-laying. The microspectroscope shows that this pink colour is that of oxyhæmoglobin. Moreover, at the same time as the pink colour is increasing in the ovaries, the blood becomes paler. This decrease in the hæmoglobin content of the blood may amount to one-third. The inference is that hæmoglobin passes from the blood into the eggs as they develop in the ovary. The course of the decrease during the six hours before the moult, which immediately precedes egg-laying, has been studied quantitatively in a number of individual *Daphnia*. It is at first gradual and then rapid. Part of the final decrease in the pink colour of the blood is due not to a loss of hæmoglobin but to a dilution of the blood resulting from the moult and the increase in body-size which is its consequence. This dilution, however, accounts only for a small proportion of the decrease in blood colour. After egg-laying, the hæmoglobin of the blood is gradually regenerated to its original level. The course of this regeneration has been followed quantitatively over the 2–3 days during which the embryos develop in the brood pouch and are finally liberated prior to the next moult.

The molecules of *Daphnia* hæmoglobin appear to be of two sizes, with weights respectively one-half and six times that of mammalian hæmoglobin; the

larger molecules are the more abundant[3]. The passage of this protein from the blood into the ovary raises an interesting problem. Either the blood haemoglobin must be rapidly broken down and the products rapidly resynthesized in the ovary, or else the haemoglobin molecule as such crosses the cell membranes. This would not be the sole case where the passage of a protein molecule across a cell membrane is suspected. Other examples are found in the secretion of hormones and enzymes, virus penetration and the particularly relevant case of the acquisition of passive immunity in birds' eggs. Here the antitoxin passes from the blood serum of the bird into the eggs[4,5].

A full account of this work will be published elsewhere. I wish to express my sincere thanks to Prof. H. Munro Fox for his interest and advice.

ELISABETH I. B. DRESEL

Bedford College,
University of London.
Oct. 7.

[1] Fox, H. Munro, *Proc. Roy. Soc.*, B, **135**, 195 (1948).
[2] Teissier, G., *C.R. Soc. Biol., Paris*, **109**, 813 (1932).
[3] Svedberg, T., and Eriksson-Quensel, I.-B., *J. Amer. Chem. Soc.*, **56**, 1700 (1934).
[4] Fraser, D. T., Jukes, T. H., Branion, H. D., and Halpern, K. C., *J. Immunol.*, **26**, 437 (1934).
[5] Andrewes, C. H., *J. Path. and Bact.*, **48**, 225 (1939).

Effect of Carbon Dioxide on Availability of Manganese in Soil Producing Manganese Deficiency

A SERIES of experiments, extending over several years, in which potato plants were grown both in pots and in the field, in soil producing manganese deficiency, from the recently drained lake-bed at East Malling Research Station, has led us to suspect the presence of some hitherto unexplained factor influencing manganese availability. The soil in question is an alluvial deposit containing a large amount of calcium carbonate and organic matter and has a *p*H of 8·0–8·5. The soil contains ample manganese, as simple extractions in Morgan's solution yield considerably more than 50 p.p.m. of manganese on a dry soil basis. This, however, is only a small fraction of the total, as is shown by extractions with strong acid. The amount of manganese available to the plant is, on the other hand, very small, since plants containing less than 1 p.p.m. on a fresh weight basis and showing acute deficiency symptoms are of common occurrence in certain areas of the lake-bed. Attempts to reproduce these conditions using the same soil in pot culture never succeeded in producing plants showing such marked symptoms or low manganese contents, although the soil *p*H was maintained between 8·0 and 8·5 by irrigating with water saturated with calcium carbonate. Water extracts of soil taken either from pots or the lake-bed itself showed negligible amounts of extractable manganese, although the plants grown in pot culture in the summer of 1948 showed no manganese deficiency, while those grown in 1947 were much less deficient than those growing on the lake-bed.

Consideration of these facts led to the hypothesis that local accumulations of carbon dioxide within the root-masses might render manganese available without producing perceptible changes on the *p*H of the soil as a whole. The following experiment was therefore carried out. Some uniformly mixed soil (water content 9·0 per cent) was collected and finely ground. Portions of 250 mgm. each were weighed out into 150 ml. conical hard-glass flasks, well corked, and were left in contact for forty-eight hours with high-grade water re-distilled in quartz. The water used was divided into two parts, one of which was saturated with acid-free carbon dioxide at 20° C. and the other boiled. Mixtures in varying proportions were used, keeping the total volume at 25 ml. A flask was also set up in which the water was kept saturated with carbon dioxide during the extraction. After extraction the liquid was centrifuged to remove soil particles, and the *p*H and amount of manganese extracted determined. The results are given in the accompanying table.

ml. boiled water	ml. water saturated with CO_2	p.p.m. of Mn extracted calc. on dry soil	*p*H of extract
25	—	<0·1	8·0–8·5
24	1	<0·1	8·0–8·5
23	2	<0·1	8·0–8·5
21	4	<0·1	8·0–8·5
17	8	0·4	8·0
9	16	2·6	7·5
—	25	5·6	7·5
—	25 kept sat. with CO_2	22·0	6·0

Owing to the extremely localized accumulation of carbon dioxide likely to occur in the soil, and the large excess of calcium carbonate present, no general changes in *p*H have been detected in the pot cultures, which remained uniformly above *p*H 8·0.

The liberation of manganese by these local accumulations of carbon dioxide would go far to account for the patchy distribution of symptoms found in the field and the higher manganese contents of pot plants with a more compacted root system. Owing to the rain early in the summer of 1948 the soil of the pots was saturated with water for several weeks, while in 1947 these conditions did not occur, which may explain the observed differences in manganese uptake.

B. D. BOLAS
G. B. PORTSMOUTH

Research Institute of Plant Physiology,
Imperial College of Science,
London, S.W.7.
Sept. 17.

Protection of Grain against Weevils

TO-DAY, the losses of foodstuffs caused by insects, principally weevils, often disregarded in pre-war days, cannot be overlooked. A conservative estimate has been made that on the average losses of ten per cent of all stored food are caused by insects[1]. In the tropics the life-cycle of weevils and other insect pests is accelerated as the temperatures are close to the optimum and, furthermore, breeding is continuous throughout the year, so that the losses can attain appalling proportions—samples of grain offered for sale have been seen in which more than 50 per cent of the individual grains have been seriously damaged. In such infested grain there is a further attack by the flour beetle, *Tribolium castaneum*, which spoils the little good grain remaining by the taint.

During the last few years investigations have been in progress on inert dusts of local origin, some of which, notably diatomite, have been found to give

fair protection. Jepson[2], in Tanganyika, has most successfully employed a 'Gammexane' dust diluted with diatomite, at a rate to provide 1 p.p.m. of the gamma isomer. The Ministry of Food has objected to this very small concentration on the grounds of possible poisonous effects; true, there is a danger of applications of the dust being made by each successive handler. Pyrethrum powder, a local product, has often been suggested as a protectant; but on account of its supposed short life has not been used. In September last an experiment was started in which diatomite, diatomite–pyrethrum dusts and pure pyrethrum powder were used. Four types of grain were included: clean maize, weevily maize, clean wheat and weevily wheat; unfortunately the 'clean' maize became infested *en route* and should be placed in the category of 'slightly weevily'. Six treatments were included, namely: untreated; diatomite alone, at the rate of 2 lb. per 200-lb. bag; three diatomite–pyrethrum dusts of increasing pyrethrum concentration, also at the rate of 2 lb. per 200-lb. bag; and, finally, pyrethrum powder, fairly finely ground, at the rate of 1 lb. per bag. Each treatment was replicated four times, and the bags were stacked in a randomized block, which ensured continuous infestation of the whole stack from the untreated weevily bags.

At the end of a week, counts made on random samples drawn from all the bags in the stack revealed that all the treatments had reduced the numbers of living weevils to a highly significant degree. Complete protection was given by all pyrethrum treatments over three months, though in the diatomite lot a few live weevils were found. At the end of six months, the infestation in the bags treated with the weakest pyrethrum–diatomite dust (20/80) had become mild. Complete protection has been afforded by the other two dusts and the pyrethrum powder for eight and a half months when, for the first time, random samples revealed living weevils in significant numbers. At the end of this period the untreated 'clean' wheat contained 57·3 per cent of damaged grains; the grain treated with diatomite alone 12·5 per cent; that with the weakest dust 3·5 per cent; while only a fraction of 1 per cent was damaged in those protected with the two stronger dusts and pyrethrum powder. There is evidence that an application of less than 1 lb. a bag will provide adequate protection, especially if the powder be more finely ground[3].

Perhaps the most interesting point established in these experiments is the unexpectedly long life of pyrethrum powder in bagged grain. Since the effect is very rapid, there would be no chance of stray weevils entering bags of grain treated with pyrethrum powder being able to lay eggs. The long protection given would also tend to destroy weevils emerging from grain lying on the floor of the warehouse; thus, complete protection for a much longer period than eight months may be confidently expected.

The detailed results of these experiments will be published elsewhere.

V. A. Beckley

Pyrethrum Board of Kenya,
Department of Agriculture,
Nairobi, Kenya.
June 14.

[1] Freeman, J. A., and Turtle, E. E., "Insect Pests of Food". (The Control of Insects in Flour Mills.) (London: H.M. Stationery Office, 1947.)
[2] Jepson, W. F., Annual Reports Dept. Agriculture, Tanganyika Territory, 1946, 1947.
[3] Warner, P. G., unpublished data.

Fast Neutron–Proton Scattering and the Law of Interaction between Nucleons

In order to use the results of experiments on the scattering of high-energy neutrons by protons to obtain information about nuclear interactions, it is necessary to calculate the expected angular distribution of the scattered neutrons and the total collision cross-section for a large variety of different possible types of nuclear interaction.

Until now, practically all calculations of the scattering which have taken account of non-central forces have assumed a spherical well, radius $2{\cdot}80 \times 10^{-13}$ cm., as the shape of the interaction. Recently Hu and Massey, in a paper to appear shortly in the *Proceedings of the Royal Society*, have calculated the appropriate interaction constants for a number of different shapes of interaction. Following Rarita and Schwinger[1], they investigated three types of the n—p interaction with exchange properties suggested by the symmetrical, charged and neutral meson theories, which we shall call interactions I, II and III respectively. For states of even parity the interactions were taken as the same for each type of force, namely,

$$^1V_{\text{even}} = -\frac{\hbar^2}{Mr_0^2}\, gV\left(\frac{r}{r_0}\right),$$

$$^3V_{\text{even}} = -\frac{\hbar^2}{Mr_0^2}\, a\,(1+\gamma S_{12})\, V\left(\frac{r}{r_0}\right),$$

r being the range of the interaction, S_{12} the tensor force operator, and g, a, γ dimensionless constants; this g is not the same as the g used by Rarita and Schwinger.

The interaction functions $V\left(\frac{r}{r_0}\right)$ investigated were of the following forms:

(1) Spherical well $V\left(\frac{r}{r_0}\right) = 1$ for $r < r_0$, $= 0$ for $r > r_0$

(2) Yukawa potential $V\left(\frac{r}{r_0}\right) = \left(\frac{r_0}{r}\right)\exp\left(-\frac{r}{r_0}\right)$

(3) Exponential potential $V\left(\frac{r}{r_0}\right) = \exp\left(-\frac{r}{r_0}\right)$

(4) Gaussian potential $V\left(\frac{r}{r_0}\right) = \exp\left\{-\left(\frac{r}{r_0}\right)^2\right\}$

For a variety of ranges, r_0, Hu and Massey determined a, g and γ to give correctly the binding energy, the energy of the virtual singlet state, and the quadrupole moment of the deuteron.

A knowledge of these interaction constants has made possible a systematic investigation of the dependence of the total cross-section and angular distribution in high-energy n—p scattering on the range and shape of the assumed interaction. Accurate calculations of this type are at present being carried out in this Department for incident neutron energies in the range 100–250 MeV. These calculations are very lengthy, however, and in the meantime we have used the Born approximation to calculate the scattering in this energy range.

Ashkin and Wu[2] have investigated the validity of this approximation in the case of the spherical well of range $2{\cdot}80 \times 10^{-13}$ cm. They found that although it is not very good at neutron energies of 100 MeV., it gives fairly good agreement with exact calculations

for neutron energies of 200 MeV., the agreement being poorest in the case of interactions of type II.

In general, the Born approximation appears to give rather too large a value of the total cross-section. This is shown, for example, in Table 1, which compares the total cross-section as calculated by the Born approximation in the present work with exact values obtained previously by Massey, Burhop and Hu[3]. These values refer to a spherical well interaction of range $2{\cdot}80 \times 10^{-13}$ cm., and incident neutrons of energy 83 MeV.

Table 1

	Total cross-section ($\times 10^{26}$ cm.^{2})			Ratio $\sigma_{180°}/\sigma_{90°}$		
	Inter. I	Inter. II	Inter. III	Inter. I	Inter. II	Inter. III
Exact theory	14·10	15·77	23·38	10·2	3·67	0·58
Born approximation	19·05	23·32	23·32	11·3	3·56	0·53

Table 1 shows also that the ratio $\sigma_{180°}/\sigma_{90°}$ of the differential cross-section at 180° to that at 90° in the c.m. system is given fairly well by the Born approximation.

For other forms of interaction one would expect the Born approximation to give better results than in the case of the spherical well. Thus, for a purely central type of Yukawa interaction of range $1{\cdot}18 \times 10^{-13}$ cm. and symmetrical forces, Chew and Goldberger[4] found that the Born approximation gives a total cross-section about 7 per cent too large at 100 MeV.

(4) The decrease of total cross-section with increase of neutron energy is more rapid with the longer range interactions.

(5) The spherical well shape of interaction tends to give a larger total cross-section and a smaller ratio of $\sigma_{180°}/\sigma_{90°}$ than the other shapes. This, however, could arise partly from the poorer accuracy of the Born approximation in the case of the spherical well.

The Berkeley measurements of the total cross-section gave the value $8{\cdot}3 \pm 0{\cdot}4 \times 10^{-26}$ cm.^{2} for 90 ± 13 MeV. neutrons[5]. Of all the interactions investigated, the only one that gives a value approaching this is the Yukawa potential of range $1{\cdot}18 \times 10^{-13}$ cm. for type I interaction, which gives a value of $9{\cdot}1 \times 10^{-26}$ cm.^{2}. According to the interaction constants given by Chew and Goldberger[4] and used for this range, the triplet interaction in this case is almost wholly non-central.

The provisional experimental value[6] of $\sigma_{180°}/\sigma_{90°}$ is about 3. This seems to rule out any kind of type III interaction. The Yukawa symmetrical case of range $1{\cdot}18 \times 10^{-13}$ cm. gives about 6·2 for this ratio. It seems to be a feature of the angular distribution in the case of the Yukawa potential with type I interaction, however, that there is a sharp increase in differential cross-section at scattering angles near 180°. In such a case an experimental measurement might be expected to give a value of $\sigma_{180°}/\sigma_{90°}$ somewhat too small.

A full account of these calculations will be published elsewhere.

Table 2

Shape of Interaction	Range $\times 10^{13}$ cm.	Total cross-section ($\times 10^{26}$ cm.^{2}) Inter. I		Inter. II and III		Ratio $\sigma_{180°}/\sigma_{90°}$ Inter. I		Inter. II		Inter. III	
Neutron energy in laboratory system (MeV.)		100	250	100	250	100	250	100	250	100	250
Spherical well	3·49	19·0	7·5	22·1	8·5	75	1240	37	757	0·12	0·68
	3·05	17·6	7·4	20·3	8·1	25·8	2190	8·9	942	0·26	0·40
	2·80	17·0	7·7	20·7	8·7	12·9	136	3·7	48·2	0·30	0·05
	2·62	16·8	8·0	22·2	10·0	7·6	36·5	1·5	8·7	0·44	0·04
	2·18	25·5	15·3	48·9	30·8	2·4	3·1	0·44	0·62	0·98	0·01
Yukawa potential	2·18	14·1	6·0	16·6	6·6	90	397	64·8	269	0·34	0·31
	1·74	11·9	5·5	13·8	6·4	38	152	18·9	64·4	0·40	0·35
	1·18*	9·1	5·9	16·5	10·4	6·2	14·3	0·61	1·29	0·59	0·43
Exponential potential	1·09	15·3	6·2	17·6	7·0	99·5	562	43·0	237	0·28	0·20
	0·87	12·6	5·9	15·3	7·1	22·7	102	8·5	31·9	0·39	0·25
Gaussian potential	2·18	14·9	6·5	17·7	7·5	32·9	266	12·3	91·9	0·25	0·13

* The constants used for this range are approximate ones given by Chew and Goldberger[4].

Table 2 shows the results of the present calculations. Some general conclusions to be drawn from this table are as follow:

(1) The total cross-section for interaction types II and III is always larger than for type I.

(2) The ratio $\sigma_{180°}/\sigma_{90°}$ is greatest for interaction I and always less than 1 for interaction III.

(3) As the range of interaction decreases, the total cross-section passes through a minimum and then starts to increase again while the ratio $\sigma_{180°}/\sigma_{90°}$ continually diminishes. The increase of the total cross-section at very short ranges is associated with the increasing importance of the tensor force. In the extreme case of a spherical well of range $2{\cdot}18 \times 10^{-13}$ cm., the non-central interaction is so large that the central interaction has to be made repulsive to give the correct deuteron binding energy.

We are greatly indebted to Prof. H. S. W. Massey and Dr. Tsi-Ming Hu for allowing us to use, prior to publication, the interaction constants calculated by them, and for valuable discussions during the course of the present work.

E. H. S. Burhop
H. N. Yadav

Mathematics Department,
University College,
London, W.C.1.
July 28.

[1] Rarita and Schwinger, *Phys. Rev.*, **59**, 436, 556 (1941).
[2] Ashkin and Wu, *Phys. Rev.*, **73**, 973 (1948).
[3] Massey, Burhop and Hu, *Phys. Rev.*, **73**, 1402 (1948).
[4] Chew and Goldberger, *Phys. Rev.*, **73**, 1408 (1948).
[5] Cook, McMillan, Peterson and Sewell, *Phys. Rev.*, **72**, 1264 (1947).
[6] Hadley, Leith, York, Kelly and Wiegand, *Phys. Rev.*, **73**, 541 (1948).

Photo-Elastic Effect in Barium Nitrate

During the course of our investigations on photo-elasticity, we have found that single crystals of barium nitrate behave in many respects in an exceptional manner. Differences between the stress-optical constants as determined by a Babinet compensator are $(q_{11} - q_{12}) = -23{\cdot}81 \times 10^{-13}$, $(q_{11} - q_{12}) = -18{\cdot}06 \times 10^{-13}$ and $q_{44} = -1{\cdot}62 \times 10^{-13}$ c.g.s. units for the sodium D lines. $(q_{11} - q_{12})$ and $(q_{11} - q_{12})$ furnish a measure of the birefringence caused when pressure is applied along a cube axis.

Values given above for barium nitrate are the largest so far obtained for any cubic crystal. These values are not only larger than those hitherto reported for other cubic crystals, but are also larger than the corresponding value for most glasses, which does not generally exceed 10×10^{-13}. Barium nitrate crystals belong to the T_h class and we would expect $(q_{11} - q_{12})$ to be different from $(q_{11} - q_{12})$. It is an interesting feature that the difference in this case is nearly 27 per cent, and is much larger than that observed by us earlier in potassium and ammonium alums[1]. It is also to be noted that for this substance the birefringence produced by a pressure along a cube axis is nearly fifteen times that produced by an equal pressure along a cube diagonal. This should be regarded as a large anisotropy, as the corresponding figure for potassium alum, its nearest approach, is only eight times.

S. Bhagavantam
D. Suryanarayana

Department of Physics,
Andhra University,
Waltair, India.
May 28.

[1] *Proc. Ind. Acad. Sci.*, **26**, 97 (1947).

Inclusions in Aluminium Crystals

It appears from various experiments that the ease with which a crystal can grow in a deformed matrix depends very much on the mutual orientation of growing and disappearing lattice domain. This is already obvious from the fact that, in a recrystallizing coarse-grained material, the new crystals show corrugated boundaries, demonstrating visibly that some of the original grains are consumed at a faster rate than others[1]. Recent experiments give a far more striking proof of this phenomenon.

It was observed by Carpenter and Elam[2] in their original paper on the preparation of aluminium crystals by the stress-strain method that the large crystals so obtained often contain small included domains with deviating orientation, which were obviously unabsorbed grains from the original fine-grained material. These inclusions proved to be very stable against prolonged heat treatment (see, for example, Seumel[3]).

It struck us that in a crystal with a number of inclusions, several of these domains reflected incident light at the same moment, thus pointing to a more or less identical orientation. It seemed worth while to determine this orientation, and to look for a relation between the orientation of the 'mother crystal' and the orientation of the included domains. As the dimensions of these domains depend on the grain size of the matrix, they can vary considerably, so that it is not always possible to determine the orientation of an inclusion by X-ray methods. In these cases the etch method, developed for aluminium by Lacombe and Beaujard[4], was used. By this method tiny cubic etch-pits are developed, and the boundary lines of the pits are therefore traces of (100) planes on the surface of the test piece. Starting from the orientation of the mother crystal (determined from a Laue transmission photograph), the (100) traces to be expected for the four spinel twin orientations were constructed by means of stereographic projection. It was found that the pits in the inclusions had orientations which coincided with the four twin possibilities within about 5°. Fig. 1 shows two different twins in the same mother crystal.

The orientation of larger inclusions (approximately 0·2 mm. diameter) could be obtained by X-ray methods (Laue transmission photographs). These photographs consisted of the superimposed Laue patterns of mother crystal and inclusion; as the pattern of the included domain showed a marked asterism as a result of the deformation before recrystallization (this proves at the same time that the included domain is no new crystal), it was not difficult to separate them. The photographs confirmed the relationship between the orientations already found by the etch method. Fig. 2 shows the Laue patterns of mother crystal and inclusion superimposed; the enclosed spots would have coincided for an exact twin relationship.

According to these experiments, it seems to be difficult for a growing crystal to consume those lattice blocks which occupy approximately a twin position. From this it might be deduced that in order to prepare large aluminium crystals by the stress-strain method without such inclusions, one has to start from fine-grained material of such 'narrow' texture that a growing crystal has no chance of meeting its (approximate) twin position. A second point is the striking difference in behaviour between grains in *approximate* twin position and lattice blocks which give rise to exact twins. As was found in earlier work[5], a growing crystal may induce ('stimulate') a block to become an active nucleus, which develops into an exact twin with regard to the stimulating crystal (for a more extensive account on exact twins in aluminium and the idea of 'stimulation' we refer to ref. 6).

At the moment, we have not yet been able to analyse the geometrical relationship between two

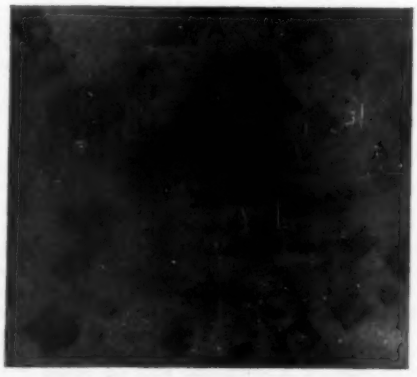


Fig. 1. Part of an aluminium crystal, *A*, containing an 'unconsumed' inclusion, *B*, with cubic etch pits. From the relative position of the etch pits it can be deduced that the inclusion *B* is approximately a spinel twin with regard to *A*. × 300

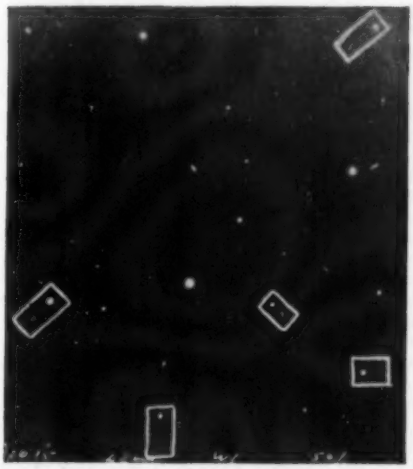


Fig. 2. Superimposed Laue patterns of a large aluminium crystal (sharp spots) and of an unconsumed inclusion of the original deformed matrix (slightly elongated spots). Pairs of spots enclosed by ▭ would coincide if the orientation relationship between crystal and inclusion was exactly that of a spinel twin

twin orientations sufficiently to understand why consumption of an approximate twin lattice is apparently so difficult.

Note added in proof. In recent work by P. A. Beck, M. L. Holzworth and Ph. Sperry on grain growth in Al–Mn alloys (1948) it was similarly found that the large crystals, which develop on continued heating of special fine-grained recrystallized material by a process of 'exaggerated' or 'discontinuous' grain-growth (also called 'secondary recrystallization'), leave unconsumed definite small grains of the original matrix: Prof. Beck kindly put some of his crystals at our disposal, and here also the same 'approximate twin-relation' between large crystal and imbedded inclusion was found.

W. May
T. J. Tiedema
W. G. Burgers

Laboratory for Physical Chemistry,
Technical University,
Delft.
June 1.

[1] Burgers, W. G., *Proc. Roy. Acad. Sci. Amsterdam*, **50**, 595 (1947).
[2] Carpenter, H. C. H., and Elam, C. F., *Proc. Roy. Soc.*, A, **100**, 329 (1922).
[3] Seumel, G., *Z. Krist.*, **93**, 249 (1936).
[4] Lacombe, P., and Beaujard, L., *J. Inst. Metals*, **74**, 1 (1947).
[5] Burgers, W. G., *Nature*, **157**, 76 (1946); **160**, 398 (1947).
[6] Burgers, W. G., and May, W., *Rec. trav. chim. Pays-Bas*, **64**, 5 (1945).

Electrokinetic Potentials of Aged Barium Sulphate Crystals

Electrokinetic methods can be used with great advantage in the study of the adsorption of electrolytes or potential-determining ions on crystalline substances. One of us[1] determined the streaming potentials in diaphragms of precipitated and aged barium sulphate, as a function of the composition of the bathing electrolyte solution. Reyerson, Kolthoff and Kieth Coad[2] have recently confirmed in a general way these results, with the exception that they found a constant negative charge in hydro-alcoholic (50 per cent) solution of potassium chloride (10^{-5} *M*). Ruyssen[1] had found that by the replacement of the aqueous potassium chloride solution by a hydro-alcoholic one the initial negative charge was reversed.

We have re-investigated the point under discussion with the same samples of barium sulphate and the following experimental facts were definitely established: (1) The charge of the barium sulphate was negative in both aqueous and hydro-alcoholic potassium chloride (10^{-5} *M*) solution, provided these were the first solutions with which the crystals came in contact. (2) When the aqueous potassium chloride solution was displaced by a hydro-alcoholic one, the measured charge became positive. When the crystalline substance was taken out of the diaphragm and thoroughly washed and shaken with the same liquid, its charge was again reversed to negative. (3) When the hydro-alcoholic solution of the first experiment was displaced by pure water, the crystals were charged positively. (4) In a saturated barium sulphate solution, without other electrolytes, the crystals became again negatively charged.

We may conclude that the normal equilibrium charge of pure barium sulphate is negative in aqueous potassium chloride solution and saturated barium sulphate solution as well as in hydro-alcoholic potassium chloride solution. This is in agreement with Reyerson *et al.*[2], but not with the positive streaming potentials found by Buchanan and Heymann[3] of natural barytes and recrystallized barium sulphate. On the other hand, we confirmed the experimental fact of the reversal of the charge of the barium sulphate when the aqueous solution is displaced by a hydro-alcoholic one, although this seems not to be the equilibrium charge. It seems that in the hydro-alcoholic medium there is a precipitation of the barium sulphate out of the displaced saturated aqueous solution, followed by preferential adsorption of the Ba^{++} ions.

R. Ruyssen
R. Loos

Department of Medical Chemistry,
University of Ghent.

[1] Ruyssen, R., *J. Phys. Chem.*, **44**, 265 (1940). Kruyt, H. R., and Ruyssen, R., *Kon. Acad. Wetenschappen Amsterdam*, **37**, 498 (1934).
[2] Reyerson, L. H., Kolthoff, I. M., and Coad, K., *J. Phys. Chem.*, **51**, 321 (1947).
[3] Buchanan, A. S., and Heymann, E., *Nature*, **161**, 649 (1948).

Factors Controlling the Atlantic Coastline of Europe

In 1938, W. V. Lewis[1] pointed out that the general line of a shore tends to be at right angles to the direction of dominant wave-attack, and that as a bay becomes adjusted to this attack it tends to become asymmetrical, with the longer, smoother side facing the quarter from which the dominant waves approach. In 1940[2], I suggested that the theory applied by Mr. Lewis to beach material and easily eroded cliffs might be developed to explain the outline of the larger bays of south-west England. I showed that this would account for the fact that their eastern sides have been rendered comparatively smooth, with blunted headlands, while their western sides have been protected from dominant wave-attack, so that their indented minor bays have been preserved between angular promontories.

Various geologists have since suggested to me that this view of coastal development may be applicable

to widely scattered parts of the world. In particular, I am indebted to Mr. E. E. S. Brown (now president of the Geologists' Association) for pointing out to me that both the west coast of Ireland and the Bay of Biscay are exposed to the full force of the Atlantic, while the coast of north Spain runs parallel to the line of wave-attack and is thus comparable with the coast of north Devon. These suggestions have led me to a further study of the map of western Europe from this point of view.

The outline of the Atlantic coast of France, Spain and Portugal is notable for its relative simplicity, the single northward-facing stretch turning at either end almost at a right angle into the westward-facing sectors. If wave-attack has been largely responsible for the smoothing of the westward-facing coasts, this is an illustration of the power exerted when the direction of prevailing winds happens to coincide with the direction of the greatest stretch of open ocean. In western Europe, the Westerly winds blow direct off the open Atlantic. The relation of the shore to wave-attack may possibly be very different on a coast such as that of eastern Canada, where the prevailing wind is offshore.

Sketch-map of Western Europe: Armorican structure shown by continuous lines, Alpine structure by broken lines. Arrows indicate approximate direction of prevalent winds. (Bonne's projection)

Moreover, in western Europe the direction of the open ocean and prevailing winds happens to lie at right angles to the principal structural lines. The northern limit of Armorican, otherwise known as Hercynian, folding (originating in Permo-Carboniferous times) ran approximately east and west through south-west Ireland and southern England, resulting in the mountain ranges, now worn down to mere stumps, of Devon and Cornwall and of Brittany. Following the older Caledonian lines of weakness, running in a rather more north-east to south-west direction, granites were injected into Devon and Cornwall; the granite of the Land's End protects the peninsula rather as the ferrule protects a walking-stick. A corresponding series of igneous and metamorphic rocks form the backbone of the Breton peninsula. The English Channel has eaten its way into the lower ground between Cornwall and Brittany, and, still farther south, the west of France is traversed by valleys where a submergence of about 600 ft. would unite the Bay of Biscay with the Gulf of Lions in a strait through the 'Gate of Carcassonne'.

The next rib in the skeleton of western Europe is the Pyrenees, which, although dating from the Alpine orogeny of Tertiary times, follow the same east and west axis as the earlier Armorican folds. Thus the general trend of the north coast of Spain runs straight from the Alpine Pyrenees into the Alpine and Armorican Cantabrians. The great block of the Iberian peninsula consists of the Meseta, which is lapped round in the south by the Betic Cordillera folded in the Alpine period. The structural control is continued in North Africa by the Alpine range of the Atlas Mountains, the sea having broken through between the Atlas and the Betic Cordillera to form the Strait of Gibraltar. Much of the Atlantic coast of Spain and Portugal lies in 'Mediterranean' latitudes, south of the Westerly wind belt, but owing to the relation of land and sea it is not exposed to the North-East Trades, and even in summer the winds have a westerly component. However, the Iberian coast presumably depends more for its form on structure and less on relation to winds and waves than does the coast north of the Cantabrians.

It is the east–west folds which, owing to the coincidence of the Armorican and Alpine axes, have acted as the supporting structure of western Europe, holding out the land into the Atlantic Ocean, which has eaten its way back or broken right through wherever the protection of mountain or igneous rock was lacking. Thus the coast between the east–west mountain ribs has been worn back in a north–south direction under the attack of the waves. These waves are driven by the Westerly winds approaching over the open Atlantic approximately at right angles to the main structural lines of western Europe.

MURIEL A. ARBER

52 Huntingdon Road,
Cambridge.
Sept. 21.

[1] Lewis, W. V., *Proc. Geol. Assoc.*, **49**, 107 (1938).
[2] Arber, M. A., *Nature*, **146**, 27 (1940).

'Pins and Needles'

IT is well known that the release of a constricting cuff, which is cutting off the blood-supply to a part of a limb, may be followed by the complex sensation known as 'pins and needles'; but there has been some controversy as to which part of the nerve or its branches is giving rise to the nerve impulses. Lewis *et al.*[1] and Zotterman[2] believed that the region of the nerve lying under the cuff was mainly concerned, whereas Weddell and Sinclair[3] argue that the sensation "is due to the stimulation of a proportion of the peripheral nerve endings in the area in which it is felt". Some new experiments to be described give results which appear incompatible with either of these views.

The pricking sensation of 'pins and needles' was produced by the release of a blood-pressure cuff, placed just above the elbow, which had cut off the blood-supply to the forearm and hand for twelve minutes. The pricking sensation in the normal arm

was compared with the sensation felt after blocking the ulnar nerve or its branches at various levels with procaine.

A block at the elbow, just below the cuff, entirely eliminates the sensation, which must mean that the 12-cm. stretch of nerve lying under the cuff cannot be the origin of all the impulses, or even of a majority of them, as Lewis *et al.*[1] suggested. A block of the ulnar nerve branches in the hand, however, which makes the whole or a part of the ulnar skin area anæsthetic, has only the effect of modifying the sensation, the pricks being fewer and less intense, but nevertheless clearly felt in the anæsthetic skin area. This argues against the conclusion of Weddell and Sinclair[2], since the peripheral endings are, in this case, taking no part in the production of the sensations which are perceived.

The effect of a block half-way between these extremes (that is, mid-forearm) is particularly interesting. The sensation is far less intense than with a block in the hand, although the same skin area is anæsthetized in either case : the pricks are now very few, and although clearly felt as pricks, they are individually less intense than in normal unanæsthetized skin.

These experiments suggest that the intensity and number of the pricks depend on the length of nerve which is recovering from any fixed period of depressed blood-supply, and that no part of a nerve is particularly concerned in generating the impulses which give rise to this form of 'pins and needles'. This probably explains why the pricking of 'pins and needles' is less intense when produced by a cuff at the wrist, and very feeble indeed with a cuff around a finger.

The change in the physico-chemical circumstances governing the excitability of any one nerve fibre, which occurs as the circulation is restored (the removal of a 'substance'[3]), presumably offers to all parts of that fibre the opportunity of firing off impulses, and the chance of some low-threshold point or points becoming rhythmically active should be increased when a greater length of the fibre is exposed to the changed environment.

A fuller account and discussion of this work will be published elsewhere in due course.

G. Gordon

Department of Physiology,
University of Oxford.
June 7.

[1] Lewis, T., Pickering, G. W., and Rothschild, P., *Heart*, **16**, 1 (1931).
[2] Zotterman, Y., *Acta Med. Scand.*, **80**, 185 (1933).
[3] Weddell, G., and Sinclair, D. C., *J. Neurol.*, **10**, 26 (1947).

Persistence of D.D.T. in the Soil

The note by M. S. Smith[1] concerning the persistence of D.D.T. and 'Gammexane' in soil is in conformity with the results of experiments carried out in Australia on the use of D.D.T. as a control of the scarab *Aphodius howitti* Hope, the larvæ of which infest pastures on the tablelands of south-eastern Australia.

The species has a simple annual life-cycle, the adult flights occurring in February. D.D.T. was applied to the pasture as a 2 per cent dust in talc at the rate of 3·3 lb. of *pp*-isomer D.D.T. per acre in August 1946. At this time the larvæ had almost completed their active feeding stage. No significant mortality resulted from the treatment. However, in the winter of 1947, the treated areas were completely free from infestation, while adjacent untreated areas were again infested. Indirect evidence suggests that the D.D.T. had its effect on the very young larvæ of the 1947 generation, approximately eight months subsequent to the date of treatment.

On the basis of Smith's results, it may reasonably be expected that the D.D.T. will have persisted and exercised a control of the larvæ of the 1948 generation. At the time of writing, larvæ are as yet too small to enable effective population counts to be made.

The details of this work are being published elsewhere.

Phillip B. Carne

Division of Economic Entomology,
Council for Scientific and Industrial Research,
Box 109, City,
Canberra.
June 22.

[1] *Nature*, **161**, 246 (1948).

Entomological Aspects of 'Swollen Shoot' of Cacao

The rapid spread of the deadly 'swollen shoot' disease of cacao first recorded by Steven[1] in 1936 justly gives cause for alarm. Now believed to be due to a virus transmitted by three species of insects of the family Pseudococcidæ, this malady of unknown origin bids fair to destroy the West African cacao industry. That this is realized by the people of West Africa is evident from the lively public interest in the problem.

It is not, therefore, too soon to pause and take stock of the problem. The good old-fashioned remedy of destroying affected trees and contacts, bearing as it does the stamp of common-sense, has won general support except, perhaps, from the unlettered farmer in whose egocentric view there is only one kind of dead cacao tree.

In this connexion it will be well to keep in mind the entomological aspect of the problem and see how the vectors may be controlled in the primitive conditions under which the crop is produced. One method which does not appear to have received the consideration it merits is that of biological control. In the welter of ideas about resistant varieties, immunization and cutting-out, this elementary aspect seems to have been forgotten. Yet the Pseudococcidæ are in some respects peculiarly amenable to this treatment in the tropics. In West Africa they are not heavily parasitized or preyed upon; and there is in other parts of the world a wide range of parasites and predaceous enemies which could be, possibly usefully, certainly with impunity, introduced into West Africa. I am not unaware of the provocative nature of this proposition. But those who would dismiss it untried should bear in mind the infinitesimal cost of effecting such introductions against the havoc wrought by the disease. No one can say whether the method will succeed. But it is a weapon that has proved itself elsewhere, and, in the present parlous state of the important West African cacao industry, it is one that should be tried without delay.

F. A. Squire

Department of Agriculture,
Sierra Leone.

[1] Steven, W. F., *Gold Coast Farmer*, **7**, 122 (1936).

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

THE Eighth General Assembly of the International Union of Geodesy and Geophysics, and of its seven constituent associations, was held at Oslo during August 19–28. The opening assembly, held in the large hall ('Aula') of the University of Oslo, was attended by the King of Norway and the Crown Prince. The Government of Norway and the municipality and the University of Oslo extended the most generous hospitality to the Union. A large amount of careful preparation had been done by the Norwegian Organising Committee under the chairmanship of Prof. H. Solberg, secretary of the Academy of Science and Letters.

Owing to the state of health of the president, Prof. Helland-Hansen, of Norway, the duties of president were carried out by the senior vice-president, Prof. N. E. Nörlund, of Denmark. The general secretary of the Union is Dr. J. M. Stagg, of the British Meteorological Office. The Council of the Union consists of one delegate from each country; the British member of the Council was Prof. J. Proudman. There were more than five hundred delegates and guests from about forty countries. The largest party was the British, numbering nearly eighty, of which about half were delegates appointed by the Royal Society; but the party from the United States exceeded seventy. This was the first ordinary General Assembly since the War; a small, purely administrative Assembly had been held at Cambridge in 1946, and this enabled the Oslo delegates to devote the maximum amount of time to scientific discussion. Evening lectures by Dr. M. A. Tuve, of Washington, and by Dr. S. Thorarinsson, of Iceland, the latter showing a remarkable colour film on the recent eruption of Mt. Hekla, were much appreciated. Prof. Vening Meinesz, of Holland, was elected president of the Union for the period 1948–51. An invitation from Belgium to hold the next General Assembly at Brussels in 1951 was gratefully accepted.

The Union expressed its gratitude for the very considerable financial assistance which it has received from Unesco. The major part of this has consisted of grants in aid of the permanent scientific services which are sponsored by the Union; the largest individual grant for 1948, £3,000, is in aid of the International Seismological Summary, the staff of which is housed at Kew Observatory. But many of the officers of the Union received Unesco grants in aid of their travelling expenses to and from Oslo.

A very valuable feature of the Assembly was the excursions, and it was on these that the warm-hearted hospitality of the Norwegians reached its height. It is the common experience of those attending international conferences that the personal contacts made on such excursions are, even from the point of view of the advancement of science, the most valuable part of the whole proceedings. Most delegates and guests accepted invitations to visit the district around Lillehammer on August 22. After the Assembly, forty delegates enjoyed a most entertaining and instructive visit to the hydro-electric works at Rjukan as the guests of Norsk Hydro. The meteorologists and oceanographers took part in excursions which met far up the Sogne Fjord, and from this point they were conveyed to Bergen in five research vessels, four of them Norwegian and one Scottish. The hospitality of the municipality of Bergen formed a fitting close to a memorable occasion.

Association of Geodesy. The work of the Association of Geodesy was distributed over five sections. In the Section on Triangulation there was much discussion on methods of measuring long distances, including triangulation between non-intervisible ground stations by radar and by the observation of flares dropped from aircraft. Consideration was also given to the proposal to extend the Central European Net to Western Europe. In the Section on Geodetic Levelling, deliberations were mainly devoted to refinements in the practice and theory of geodetic levelling and to the methods of research into those problems of tectonics on which levelling is capable of throwing light. The Section on Geodetic Astronomy gave consideration to co-operation with the International Unions of Astronomy and of Telecommunications. An interesting and important report on the activities of the Royal Observatory was received from the Astronomer Royal.

In the Section on Gravimetry it was noted that since 1939 the rapid development of static gravimeters has brought them into general use, not only for geodetic purposes but more especially for geological prospecting by oil companies. As a result, the quantity of gravity material accumulating in some areas is more than can be conveniently handled in geodetic work. It was decided that the Association should set up a Gravity Bureau. In the Section on the Geoid, attention was given to deviations of the vertical, to geoidal rise and deflexions, and to the application of methods of differential geometry to geoidal determination. There was a heated discussion on the 'co-geoid-fictitious level surface of the earth' after the removal of effects of compensated topography.

Both the president of the Association, Mr. W. D. Lambert, of Washington, and its secretary, Prof. P. Tardi, of Paris, were re-elected.

Association of Seismology. This Association benefited from the fact that a preliminary meeting had been held at Strasbourg in 1947. Without world-wide co-operation the progress of seismology would have been extremely slow. A notable example of such co-operation is the International Seismological Summary, for which the Association is responsible; significant measures for increasing the usefulness of the Summary were agreed upon at Oslo. A special session of the Association was devoted to recent researches on the seismicity of the earth. One of the sessions was devoted to the study of the seismic results of the large explosions at Heligoland, Burton-on-Trent, Haslach and Soltau, and to the results of seismic prospecting in France, Spain and the United States.

The president, Dr. R. Stoneley, of Cambridge, and the secretary, Prof. J. Rothé, of Strasbourg, were re-elected.

Association of Meteorology. In his presidential address to the Association of Meteorology, Prof. S. Chapman made a strong case for an International Meteorological Research Organisation to link together the various meteorological research bodies throughout the world, and to serve as a clearing house for ideas. A strong impression was created by the discussion

on rain-making by artificial means. Other important contributions included the following: a theory of selective unstable waves in an atmosphere described by the boundaries of the tropopause and the earth's surface, a subject which is connected with the formation of short-lived cyclones; fundamental problems in the study of radiation; the density of the high atmosphere as determined by the motion of meteorites; the need for more observations of water vapour and of helium in the high atmosphere; antarctic meteorology; jet streams; and the possibilities of statistical forecasting. Mr. A. W. Brewer exhibited an automatically controlled frost-point hygrometer, based on the design which he and Dr. Dobson had evolved, and gave an impressive account of the water vapour content above the tropopause. Prof. Byers showed a film exhibiting in slow motion the records of radar reflexion from rain during thunderstorms over Florida.

Prof. J. Bjerknes resigned the office of secretary and was elected president; Prof. J. van Mieghem was elected secretary.

Association of Terrestrial Magnetism and Electricity. The discussions of this Association included the following subjects: the influence of solar activity on terrestrial magnetism; air-borne magnetic surveys carried out in the United States and in Britain, which show great promise for the near future; the origin of the earth's magnetism; diurnal variation of the horizontal force near the magnetic equator; detection of rapidly moving ionic 'clouds', observed during ionospheric storms; and the use of *V*2 rockets for the exploration of the upper atmosphere.

Owing to the absence of the president, Dr. J. A. Fleming, of Washington, the chair at the early meetings was taken by Prof. J. Coulomb, of Paris; Prof. S. Chapman, of Oxford, was then elected president, and presided at the later meetings. The secretary, Dr. J. W. Joyce, of Washington, was re-elected.

Association of Physical Oceanography. A change of emphasis as compared with those at earlier Assemblies was shown in the meetings of the Association of Physical Oceanography. Previously, most attention was given to the distribution of temperature and salinity in the oceans and to the deductions regarding water-movements, etc., which could be drawn from such distributions. On this occasion, most attention was given to observations of oscillations in the sea, including surface-waves, turbulence and storm-surges. The change reflects a result of the War, which prevented ocean-going expeditions and turned attention to problems associated with the landing of troops on beaches. For the first time, British oceanographers took a prominent part in the presentation of papers.

Most of the standing scientific committees of the Association, including those on mean sea-level, ocean bottom, weather ships and technical handbook, were reappointed, while a new one on bibliography was set up. The president, Prof. H. U. Sverdrup, of Oslo, was re-elected. Prof. J. Proudman, of Liverpool, resigned the secretaryship, and Prof. H. Mosby, of Bergen, was appointed to succeed him.

Association of Vulcanology. In the absence of the president, Prof. Michel-Lévy, of Paris, owing to ill-health, the Association of Vulcanology met under the chairmanship of one of the vice-presidents, Prof. B. G. Escher, of Leyden. His address was on the asymmetrical shape of the earth's surface and its effect upon the volcanism of the earth and the moon. Contributions included reports dealing with volcanic activity during the past decade, in Japan, Kamchatka, the East Indian archipelago, Guatemala, the West Indies, Africa, Iceland, Etna, Vesuvius, and elsewhere. Few vulcanologists attended the meeting, which is largely to be ascribed to the coincidence in time of the International Geological Congress in London.

Two new objects were brought forward, and to these particular attention was given. A commission was set up under the chairmanship of Prof. L. Glangeaud for the purpose of studying the extinct volcanoes of the world with special reference to the relations between geological time and the changing composition of the magmas concerned. A long-standing policy of the Association, for which funds have been accumulated over a number of years, is the publication of a catalogue of the active volcanoes of the world, and a conference was held on the scope of the catalogue, and its compilation and publication. Prof. B. G. Escher, of Holland, was elected president, and Prof. F. Signore, of Italy, was re-elected as secretary.

Association of Hydrology. The work of the Association of Hydrology was spread among the four commissions: limnology, potamology, underground water, snow and glaciers. The Limnology Commission dealt with the balance-sheet of a lake, with statistics of lake-level and with the movement of water in lakes; the Potamology Commission with evaporation, with precipitation-recording methods, and with transport of solid material in Nature and in the laboratory; and the Underground Water Commission with infiltration, with variations of level in springs, and with hot springs in general.

The Commission on Snow and Glaciers, in addition to the set themes, dealt, *inter alia*, with suggested classifications of snow, and with the alternative methods of observation and reporting which are now in use in the United States and Switzerland. The report on glacier variations was the first to be made by the new permanent committee which was established at Washington in 1939 to carry on the work of the long-established Commission Internationale des Glaciers. The statistical data up to now have dealt solely with the changes of position of the glacier snouts; but in future it is planned to include three-dimensional surveys of selected glaciers. There was an exhibition of glaciological films. It was decided to reduce the number of commissions to three: underground water, lakes and rivers, snow and ice.

The Association met under the chairmanship of Prof. G. Slettenmark, of Sweden, who had been appointed acting president after the death in 1947 of Prof. O. Lütschg, of Switzerland. The secretary, Prof. F. Diénert, of France, died shortly afterwards, and his place was filled by Prof. A. M. Vibert, of France, as acting secretary. At the close of the Assembly, Mr. Merrill Bernhard, of the United States, was appointed president, and Prof. L. Tison, of Belgium, was appointed secretary.

A joint meeting of the Associations of Seismology, Meteorology and Physical Oceanography was devoted almost entirely to thirteen papers on microseisms, recent developments in this subject showing how profitable has been co-operation between workers in the different sciences. The Union Committee on Continental and Oceanic Structure was replaced by a Joint Inter-Association Committee on the Physics of the Earth's Interior.

J. PROUDMAN

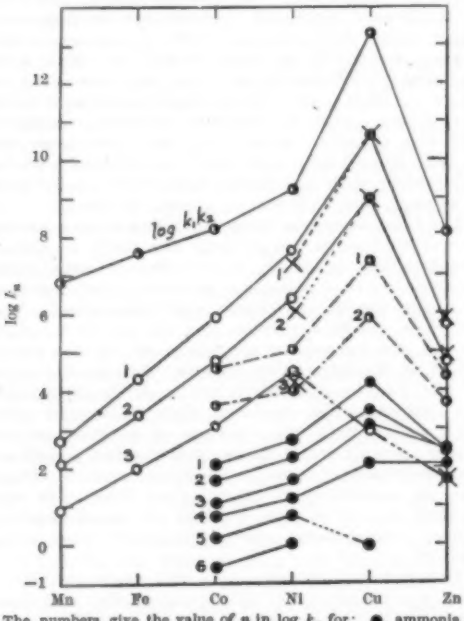
ORDER OF STABILITY OF METAL COMPLEXES

By Dr. H. IRVING and R. J. P. WILLIAMS
Inorganic Chemistry Department, Oxford

MELLOR and Maley[1,2] have recently pointed out that the stability of complexes of bivalent metal ions follows the order

$$Pd > Cu > Ni > Co > Zn > Cd > Fe > Mn > Mg$$

irrespective of the nature of the ligands involved, and remark that "although it is not clear what determines the order of metals in the series, it is worth noting that metals forming dsp_2 bonds (Cu^{II} and Pd^{II}) head the list". Although our own programme of experimental work is incomplete, it appears desirable to indicate some of our conclusions in this field, since they extend the observations of Mellor and Maley and render to some extent more intelligible the order of decreasing stability found experimentally.



The numbers give the value of n in log k_n for: ●, ammonia; ○, ethylene diammine; ×, propylene diammine; ◑, salicylaldehyde

If published data[3] on the successive stability constants of divalent ions of the first transition series are plotted against their atomic number (see graph), it is seen that the stability of complexes increases steadily to reach a maximum at copper whether the ligands be ammonia, ethylene diammine, propylene diammine or salicylaldehyde. The reluctance of copper to exceed a co-ordination number of 4 is shown by the low value of k_5 for the pentammino-, and k_3 for the tris-ethylenediammino-complexes. All zinc complexes are markedly less stable than those of Cu^{II}, and it is perhaps significant that the M-shell is completely filled in Zn^{II}, whereas the attachment of six groups through d_2sp_3 or dsp_2 orbitals (involving resonance) is possible throughout the sequence Ca^{II} to Cu^{II}. A similar trend of stabilities can be noted in the second transition series with $Pd^{II} > Cd^{II}$, but the interposition of Ag^{II} (which forms complexes isomorphous with those of Cu^{II}) can as yet be only inferred. In the third transition series, the order of stability is certainly $Pt^{II} > Hg^{II}$ and Pb^{II}.

Published data on the *absolute* stability of complexes are limited so far to those already quoted. Yet it is obvious that the formation of an inner complex represented by the equation

$$M^{n+} + n\,HR \rightleftharpoons MR_n + n\,H^+$$

involves essentially a competition between (hydrated) protons and metal cations for the anion of the reagent forming the complex: the more stable the complex, the lower the pH at which it can persist, and *vice versa*. (It is, of course, implicit that any ligand displaces an equivalent number of water molecules from the hydrated cation; for example, ammonia or pyridine displace one; diammine, salicylaldehyde or dithizone displace two, etc.) It can be shown that the pH for 50 per cent precipitation (or 50 per cent extraction of metal complexes for a constant excess of reagent) is a measure of their relative stability. Such data, with figures for the pH of incipient precipitation of metal quinaldinates and, for comparison, the stability constants of salicylaldehyde complexes are collected in the accompanying table and confirm the sequences of stability already noted.

Metal	'Oxine'; pH for 50% precipitation[3]	'Dithizone'; pH for 50% extraction with carbon tetrachloride[3]	Quinaldinic acid; pH for incipient precipitation[4]	Salicylaldehyde; log k_1k_2 in aqueous dioxane[1,2]
Mn	4·8	~9	—	6·8
Fe	—	5·6	—	7·6
Co	3·2	4·9	3·9	8·3
Ni	3·2	3·0	3·9	9·2
Cu	2·3	1·0	0·5	13·3
Zn	3·1	3·2	1·85	8·1
Pd	—	~−2·0	2·5	14·8
Cd	4·2	4·1	3·2	7·8
Pt	—	~−2·0	—	—
Hg	—	~−2·0	0·2	6·8
Pb	5·2	5·5	3·6	9·1

It is worth noting that among the divalent cations of the first transition series, copper alone is precipitated by 5:7-dibrom-8-hydroxyquinoline in normal acid[5], and similar examples of the outstanding stability of cupric complexes are commonplaces of analytical chemistry. H. Fischer[6] noted a similar order of stability for complexes with α-nitroso-β-naphthol, β-nitroso-α-naphthol and diphenyl carbazone, though the positions of cobalt and nickel were sometimes interchanged.

It must be emphasized that the order may be radically changed if the divalency of any of the participants is altered. Thus the selectivity of nitrosonaphthols as reagents for cobalt depends on their capacity to oxidize it and form a complex of trivalent cobalt far stabler than the corresponding complexes of divalent iron and nickel (or cobalt). That divalent copper, palladium (and trivalent iron) interfere with the cobalt test[7] shows that their complexes are comparable in stability even with those of trivalent cobalt. Derangement of the 'natural' order of stability may also arise from steric and other factors. Thus, copper forms normal 1:2 complexes with M-methyl- and NN′-diethyl-ethylenediammine but cannot do so with N-methyl (or ethyl)-N′-diethyl-

ethylenediammine[8]; and trivalent gallium, indium and thallium, but not aluminium, will give insoluble 1:3 complexes with 2-methyl-8-hydroxyquinoline and similar reagents[9]. We shall present elsewhere our observations with sterically hindered ligands such as α-methyl- and α : α′-dimethyl-*o*-phenanthroline.

The stability of complexes formed by any one ligand, for example, ammonia, with a series of metals may be expected to increase with the electronegativity of the metal concerned. Though reliable values for the transition elements are not yet available, it is of interest to record that a plot of instability constants (log k_n) against the second ionization potential (corresponding to the change $M \rightarrow M^{++} + 2e$ for the metal concerned) is approximately linear from manganese to copper, points for zinc lying somewhat off the curves. Thence, or less readily from the accompanying graph, it can be seen that the successive increments in stability in passing from manganese to copper complexes are of much the same order whether water is replaced by two molecules of ammonia, or one of salicylaldehyde or a diammine. When any one metal is considered, the gain in configurational entropy consequent upon ring formation is strikingly demonstrated by the high relative stability of the latter complexes.

Whereas it seems reasonably certain that the most stable complexes are always formed by elements terminating the transition series, and probable that the same 'natural' order of stability is preserved throughout each series, the acceptance of a unique order of stability operating throughout the Periodic Table must wait upon more extensive quantitative measurements with more varied types of ligands and upon a wider range of metals. Quantitative studies on chromous complexes should prove of particular interest.

[1] Mellor, D. P., and Maley, L., *Nature*, **159**, 370 (1947).
[2] Mellor, D. P., and Maley, L., *Nature*, **161**, 436 (1948).
[3] Goto, H., *J. Chem. Soc. Japan*, **54**, 725 (1933); **56**, 314 (1935).
[4] Flagg, J. F., and McClure, F. T., *J. Amer. Chem. Soc.*, **65**, 2346 (1943).
[5] Berg, R., "Die analytische Verwendung von Oxin".
[6] Fischer, H., *Mikrochemie*, **30**, 38 (1942).
[7] Feigl, F., "Spot Tests", 110 (3rd Eng. edit., 1947).
[8] Pfeiffer, P., and Glaser, H., *J. Pract. Chem.*, **151**, 134 (1938).
[9] Irving *et al.* (unpublished work).

FIRST INTERNATIONAL CONGRESS ON RHEOLOGY

SOON after the end of the War, the Committee of the British Rheologists' Club approached rheologists in the Netherlands about the possibility of holding an International Rheological Congress in Holland. Dutch rheologists welcomed the suggestion and set up a Committee to organise the Congress (see *Nature* of January 17, 1948, p. 104).

Shortly afterwards, the International Council of Scientific Unions appointed a Joint Committee on Rheology which held its first meeting in London in September 1947. The honorary secretary, Prof. J. M. Burgers, was taking a leading part in the organisation of the Congress, and it was agreed that the plans for the Congress should be made in close co-operation with the Joint Committee, the second annual meeting of which would also be held at the same date and place as the Congress itself. The Congress was held at Scheveningen during September 20–25.

The technical business of the Congress was divided into two parts: (1) general lectures given by invitation of the Committee; (2) shorter communications submitted by members. The latter part was arranged to run in three concurrent programmes, though the subject-matter was grouped in four categories: (*a*) theoretical problems; (*b*) experimental methods; (*c*) rheological properties of various systems; (*d*) biological systems.

The official languages of the Conference were English and French, the Dutch members showing a remarkable proficiency in the English language.

There was also a general discussion on nomenclature introduced in a general lecture by Prof. J. M. Burgers, who also presented a communication from the International Joint Committee. The Joint Committee had instructed two of its members, Prof. J. M. Burgers and Dr. G. W. Scott Blair, to draw up a report on nomenclature based on the various wartime publications of the British Rheologists' Club and of Dutch rheological organisations. Although developed entirely independently of one another, these reports had been found to have very much in common.

Prof. Burgers also summarized in his address the general scope of the work which the Congress was about to undertake.

The general lectures covered a wide field of rheology. Prof. F. Eirich, of the Polytechnic Institute of Brooklyn, N.Y., dealt with experimental methods in rheology, discussing the relative merits of different types of viscometers and rheometers for industrial and academic problems. Prof. C. Sadron, of the University of Strasbourg, spoke on the viscosity of dilute solutions of macromolecules, with special reference to molecular shape and orientation. This lecture was particularly valuable in drawing together information from Dutch, American, British and French sources, and in presenting a composite picture of the complex problems of viscosity-concentration relations.

Dr. M. Reiner, of the Technical College, Haifa, spoke on rheological relations in complex systems, outlining first the applications of the classical theories of elasticity and hydrodynamics, and then proceeding to discuss how the classical rheological coefficients vary with structural changes in the material and how various groupings of elastic and viscous elements are linked together to account for the behaviour of complex systems. Dr. K. Weissenberg, of the British Rayon Research Association, Manchester, also spoke on rheology of abnormal systems, developing a comprehensive scheme by which all macroscopic aspects of rheological behaviour can be dealt with whether previously regarded as 'normal' (that is, conforming to some established theory or convention) or as 'abnormal'. The scheme is based on a general theory of transformation for defining invariant rheological parameters. The lecture was ably illustrated by experiments.

Dr. G. W. Scott Blair (University of Reading) discussed psychophysical aspects of rheology, and the relationship between physical measurements and subjective judgments of rheological conditions as made by craftsmen in industry, and explored the possibilities of applying multiple factorial analysis to data from batteries of empirical rheological tests. Prof. A. L. Copley (New York University) spoke on biological problems in rheology, dealing especially with rheological problems of protoplasm, of cellular coats and intercellular substances, and on the rheology

of body fluids ('humoral rheology'). Dr. R. Houwink, of the Rubber-Stichting, Delft, who was also chief secretary of the Congress, spoke on rheology in industry, outlining the main rheological properties important for industry, with special reference to glass, asphaltic bitumen, thermoplastics, thermosetting plastics and paints.

In a short account of the Congress it is impossible to deal with all the contributions to the sectional meetings, numbering between thirty and forty papers; but it can be said that the ground covered was very wide.

There were a number of papers on thixotropy, including one by Sir Charles Goodeve, in which a novel model was described to represent thixotropic and plastic flow. Dr. H. Nitschmann, from the Harvard Medical School, Boston, described interesting experiments on thread-forming liquids, showing the relationship between this property and changes in viscosity with driving pressure. Dr. C. N. Davies, of the London School of Hygiene and Tropical Medicine, also discussed thread formation of liquids. It was somewhat unfortunate that, in an otherwise admirably arranged programme, Drs. Davies' and Nitschmann's papers were read in different sections almost simultaneously. M. M. Louis (Reuil, France) described a new type of viscometer for industrial use which should have a wide appeal on account of its simplicity of design; and a number of new rheometers were also described for the study of rubber, plastics, printing inks and other materials. Drs. H. de Bruijn and P. G. Meerman, of the Netherlands State Mines, discussed the use of a Stormer viscometer for settling suspensions, and Mr. W. Lethersich, of the Electrical Research Association, the relative merits of compression and rotation instruments for work on dielectrics.

On the theoretical side, turbulence phenomena received considerable attention; Dr. R. Schnurmann, of the Manchester Oil Refining Co., dealt with Reynolds' numbers in solutions of large molecules, and Dr. J. C. Oldroyd (Courtaulds, Ltd., Maidenhead) discussed wall-effects in turbulent flow through pipes. Prof. J. J. Hermans (University of Groningen) gave a summary of his well-known work and that of Prof. P. H. Hermans on swelling of gels, and Prof. W. T. Astbury (Leeds) gave an account of X-ray and electron microscope studies on myosin and actin.

Of the thirty-eight sectional papers, apart from general lectures, circulated in preprint form before the meeting, no less than twenty were from British rheologists, and, indeed, Great Britain was very well represented at the Congress.

An exhibition of rheological apparatus included instruments from Holland, Great Britain and France. The apparatus was classified in accordance with the way in which the stresses are applied, for example, direct, alternating, etc., whether the stress is distributed homogeneously throughout the material, or inhomogeneously, and whether the rates of shear are constant or variable. There were some sixty instruments grouped in this way. The exhibition was open during most of the Congress, and Dr. R. N. J. Saal gave a short informal address describing the exhibits and their classification.

On the evening of September 23 an informal dinner was held, Prof. H. R. Kruyt presiding. Prof. Kruyt proposed the health of the delegates, and replies were made on behalf of Great Britain by Dr. G. W. Scott Blair, of the Continental countries by Prof. C. Sadron and of the United States by Dr. A. Voet.

Following the Congress, many delegates took part in a three-day trip by touring car to Arnhem and the State Mines in the Province of Limburg. On September 25 visits were paid to the General Rayon Union, to the Staple Fibre Factory of the A.K.U., to the Netherlands Shipbuilding Experimental Station at Wageningen and to the Central Food Products Research Station. On September 26 there was a visit to the Arnhem Battlefield and on September 27 to the Central Experimental Station of State Mines at Treebeck.

The Congress was very well organised, although, in spite of the quite remarkable recovery already made, conditions in Holland are at least as difficult as they are in Britain. The Dutch organising committee must have worked extremely hard in preparing the Congress, and the unfailing kindness and help which we received from all our Netherlands colleagues, and especially from Prof. J. M. Burgers (chairman), Dr. R. Houwink (first secretary) and Dr. G. E. Rotgans (organising secretary), will long be remembered. (As Dr. Houwink said at the dinner, Dr. Rotgans turned out to be "not a bad goose, but a very good goose indeed!")

Although in existing circumstances it was felt to be unwise to fix a date and place for the Second Congress, it was the general feeling both in the Congress itself and within the International Joint Committee that congresses of this kind should be held about every four years, and the hope was expressed that the Joint Committee should recommend the calling of a Second Congress in due course.

The *Proceedings* of the First Congress will be published shortly and will be available at an approximate cost of £2 8*s*.

G. W. Scott Blair

NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE thirty-first annual report of the National Research Council of Canada (Ottawa) covers the year ended March 31, 1948, and includes the report of the president, Dr. C. J. Mackenzie, together with the financial statement. The total expenditure during the year amounted to just over 6·9 million dollars; almost a further quarter of a million dollars was expended on work carried out at the request of Government Departments and provided for by them, apart from the 7·646 million dollars received in other ways, including parliamentary appropriations of 6·351 million dollars. To cope with the expanding programme, facilities have been extended and the staff now total more than 2,300, of whom a thousand, half of them scientific workers, are working at the atomic energy project at Chalk River. The operating branch for the production and extraction of isotopes was organised during 1947, and branches of the project are concerned with the problems of operating the low-energy ZEEP and the higher-powered experimental NRX piles and handling their highly radioactive products safely and effectively. Attempts are being made to spread the new techniques and knowledge to the universities and other research institutions in Canada, and thus to foster research in these fields.

A new Division of Radio and Electrical Engineering has been established and substantial progress made in the applications of radar. In harbour control a nine-inch display with accurate ranging facilities has been added to the original installation at the Naval Signal Station at Camperdown, Nova Scotia, and procedures are being worked out for the use of shore-based radar in the identification and guidance of incoming ships that are not equipped with radar. Trials during the past season have shown that blind navigation of the entrances of Toronto Harbour and identification of every wharf within the Harbour is possible. The practical value of a direct-reading electronic instrument for locating hot joints on power lines has been demonstrated in field tests.

The Division of Physics carried out magnetometer surveys during the latter part of the year in co-operation with the Department of Mines and Resources and with the assistance of the Royal Canadian Air Force. A fundamental investigation has been started on the nature and source of cosmic rays, in particular their relation to other geophysical phenomena such as magnetic storms, and the ionosphere. A high-speed cine-camera capable of operating at a rate of 200,000 frames per second has been designed and built, and a method of geophysical prospecting has been tried in which measurements are made of the depth of overburden by vertical echo-ranging from the surface, and exploration within the bed-rock, with a device which is dropped down a drill-bed. Architectural studies include a series of commercial sound-absorption tests, while equipment has been completed for producing high-intensity sound fields at frequencies from four kilocycles to about 600 kilocycles per second, and a new rod thermostat is being developed for use in railway refrigerator cars. A summer programme of panel-cooling investigations in two experimental houses was undertaken and continued through July and August 1947, while photographic research included work on the aerial camera, the dimensional stability of photographic film bases and the factors affecting the rendering of detail in contact printing.

The organisation of the Pure Chemistry Branch has been completed, and an infra-red spectrometer installed in the section on organic spectrochemistry. Among many problems investigated in the Applied Chemistry Branch of the Division of Chemistry are the lubrication of railway car journal bearings, the correlation of laboratory abrasion tests with actual road tyre tests, the laundry application of dust-laying oils to cotton and wool hospital fabrics, corrosion inhibitors for use in various types of solution and the spreading of oil paints on certain repellent surfaces. A co-operative research with the Noranda Mines, Ltd., promises to develop a method of roasting pyrites for the recovery of elemental sulphur, and the investigation of silver alloys as catalysts for the oxidation of ethylene to ethylene oxide with air has led to the development of highly active stable catalysts. A method has been developed for the rapid determination of low concentrations of carbon monoxide in air.

Much of the work of the aeronautics section of the Division of Mechanical Engineering is devoted to wind-tunnel testing of new aircraft designs for Canadian firms; the low-temperature laboratory continued the flight investigation of aircraft icing, electro-thermal de-icing for wings and propellers and the study of meteorological conditions associated with ice. A snow-cover survey was initiated, in co-operation with the Meteorological Service of the Department of Transport, to obtain data on the type and condition of snow encountered in different parts of Canada, in order to assist in developing snow-clearing equipment and in the study of such subjects as aircraft skis. Work continued on the improvement of fuels and lubricants for use at low temperatures, and research was initiated on fuels and combustion in jet engines.

In the Division of Applied Biology, substantial progress was made in research on food preservation and the industrial utilization of agricultural wastes and surpluses. Investigations on oiling, antiseptic and gas treatment of shell eggs have facilitated shipments to Britain, and transport temperatures have been established for a milder and more acceptable bacon. Extensive work has indicated that the Fritz machine for continuous butter production, as designed for German use, cannot consistently produce butter meeting the Canadian legal standard of not more than 16 per cent moisture content. Laboratory studies on new cooling mixtures to provide lower temperatures in refrigerated railways cars gave promising results, and a study has been commenced on the fermentation of cellulose wastes, while that on the fermentation of beet molasses has reached the pilot-plant stage. Work was also commenced on the utilization of straw.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 8

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. J. Bray: "The Possibilities of Super H.F. Radio and Wave-guide Systems for Telecommunications".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. G. H. J. Daysh: "Development Areas and the Location of Industry".

Tuesday, November 9

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. A. L. Armstrong and Prof. H. J. Fleure, F.R.S.: "Discovery of a Palæolithic Skull in a Rock Shelter at Whaley, near Creswell, Derbyshire".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. P. H. Flanders: "The Physical Properties of Very High Voltage X-Rays and Electrons and their Medical Benefit".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Continuation of the Discussion on "To What Extent does Distortion Really Matter in the Transmission of Speech and Music?" (to be opened by Mr. P. P. Eckersley).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. D. Davidson: "Heat Transfer".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. W. Mitchell: "High Speed Photography".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Rubber as a Stress-Carrying Material, and some Design Considerations" (to be opened by Mr. S. W. Marsh).

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Mr. R. F. Harrod: "The Atomic Age—The Economic Repercussions of Atomic Power".*

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Rev. Brian L. Gandon: "Through India to the Himalayas".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Mr. W. H. Hillier: "The Treatment of Sewage containing Textile Effluent".

Wednesday, November 10

PHYSICAL SOCIETY, COLOUR GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. F. H. Garner and Mr. A. R. W. Baddeley: "Detergency of Carbon Black in Hydrocarbon Solution".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. M. Lacey: "The Lightning Protection of High-Voltage Transmission and Distribution Systems".

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (at King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. L. H. Lampitt: "Food Problems".

Thursday, November 11

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. Dingle: "What is Science?"•

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. M. Goody: "Thermal Equilibrium at the Tropopause and the Temperature of the Lower Stratosphere"; Prof. S. Chapman, F.R.S., and Mr. K. K. Tschu: "The Lunar Atmospheric Tide at 27 Stations widely distributed over the Globe".

UNIVERSITY OF LONDON (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. B. C. J. G. Knight: "Biosynthesis in Micro-Organisms".• (Further lectures on November 18 and 25.)

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. R. J. Smeed: "Some Statistical Aspects of Road Safety Research".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the ASSOCIATION OF PUBLIC LIGHTING ENGINEERS, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. D. Sinclair: "Fluorescent Street Lighting".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—M. Destival: "French Aircraft Gas Turbines".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Prof. C. E. H. Bawn: "The Structure and Reactivity of Free Radicals" (Tilden Lecture). (To be repeated on Friday, November 19, at the University, Glasgow.)

INSTITUTE OF METALS (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof. W. R. Jones: "Resources of Strategic Metals".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (joint meeting with the NATIONAL ASSOCIATION OF WOMEN PHARMACISTS, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. D. G. Ardley: "Some Recent Advances in Drug Therapy".

Wednesday, November 10—Thursday, November 11

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1).—Autumn Meeting.

Friday, November 12

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Some Properties of the Compression Shock as in Turbine and Compressor Blade Passages" (to be opened by Mr. I. M. Davidson).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. G. Voysey: "Techniques of a Gas Turbine Vibration Laboratory".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER CENTRE (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. D. R. Duncan: "The Colour of Pigment Mixtures".

Saturday, November 13

BRITISH PSYCHOLOGICAL SOCIETY (at Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Discussion on "Current Professional Problems of Psychologists" (to be opened by Miss Grace Rawlings and Mr. Alec Rodger).

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Major Maxwell Knight: "The Habits and Lives of British Reptiles and Amphibia".•

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the University, Reading), at 3 p.m.—Symposium on "Radioactive Tracer Elements".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Education Office, St. Mary's Gate, Derby (November 13).

SENIOR RESEARCH appointment to be made for the purpose of undertaking Government-sponsored research into problems of the location of industry—The Secretary, National Institute of Economic and Social Research, 2 Dean Trench Street, London, S.W.1 (November 13).

HEAD OF THE SCIENCE DEPARTMENT of the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (November 13).

LECTURER IN MATHEMATICS in the Physics and Mathematics Department—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (November 13).

CHIEF LABORATORY ENGINEER to take charge of a recently established Highways Laboratory at Osset, near Wakefield—The County Engineer and Surveyor, County Hall, Wakefield (November 13).

EDUCATIONAL PSYCHOLOGIST—The Director of Education, Education Offices, Cobourg Street, Plymouth (November 15).

LECTURER IN PURE MATHEMATICS in the School of Science, Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 15).

VETERINARY SURGEONS (6), and a FIELD AND RESEARCH OFFICER, in the Department of Veterinary Services, Southern Rhodesia—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (November 19).

HEAD OF THE SCHOOL OF APPLIED CHEMISTRY, Melbourne Technical College—Mr. S. L. Martin, Mathematics Department, University College, Gower Street, London, W.C.1 (November 19).

LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Hull (November 20).

EDUCATIONAL PSYCHOLOGIST—The Secretary for Education, County Buildings, Shrewsbury (November 22).

OFFICER-IN-CHARGE OF THE TESTS DIVISION—The Director, National Foundation for Educational Research, 79 Wimpole Street, London, W.1 (November 22).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 24).

LECTURER IN PHYSIOLOGY in University College, Dundee—The Secretary, The University, St. Andrews (November 30).

LEVERHULME STUDENTSHIP IN CHEMICAL ENGINEERING—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (November 30).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (December 1).

METEOROLOGICAL OFFICER CADETS (5) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 10).

MUSEUMS ASSISTANT, primarily to supervise the collections in the Kirkstall Abbey House Museum (devoted to local history and antiquities)—The Director, City Museum, Park Row, Leeds (December 20).

TRANSVAAL CHAMBER OF MINES CHAIR OF WOOD TECHNOLOGY in the University of Stellenbosch—The Secretary, South Africa House, Trafalgar Square, London, W.C.2 (Stellenbosch, December 31).

SENIOR ASSISTANT IN CHEMISTRY—The Registrar, College of Technology, The Newarke, Leicester.

SENIOR GEOLOGIST to the Government of the Gold Coast to undertake general geological work including geological mapping and prospecting—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN BIOLOGY, and a LECTURER IN CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby.

ABSTRACTORS (part-time) for the *Veterinary Bulletin*—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

LECTURER IN THE DEPARTMENT OF APPLIED CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

DEPUTY EXECUTIVE OFFICER, and a TECHNICAL OFFICER in Seed Production—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

LABORATORY TECHNICIAN IN THE DEPARTMENT OF PATHOLOGY—The Pathologist, Royal Devon and Exeter Hospital, Exeter.

SCIENTIFIC OFFICERS (2) IN THE BIOCHEMICAL DEPARTMENT for work on the separation and characterization of large molecules of biological origin—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

SENIOR TECHNICIAN (male) for training for maintenance of X-Ray, Geiger counter and other equipment in the Medical Research Council's Field Research Station at Fajara, Gambia—The Director, Human Nutrition Research Unit, National Hospital, Queen Square, London, W.C.1.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS, and EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS, as Chemical Engineers in the Ministry of Supply research and development establishments in Lancashire, Essex, Kent and Buckinghamshire—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.884/48A.

ASSISTANT INSPECTING OFFICERS (Scientific Supplies), and ASSISTANT CHEMISTS (Grade III)—The Director-General, India Store Department (Inspection Branch), 32–44 Edgware Road, London, W.2.

PHYSICIST for fundamental work on the structure and properties of fibrous materials, etc., and a PHYSICIST for laboratory and service test of shoes and shoe materials, etc.—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering.

SENIOR TRAINED BIOCHEMICAL TECHNICIAN IN THE PHYSIOLOGY DEPARTMENT—The Professor of Physiology, King's College, Newcastle-upon-Tyne.

SENIOR PHYSICS LABORATORY STEWARD—The Principal, Acton Technical College, High Street, London, W.3, quoting F.41.N.

DEMONSTRATOR IN PARASITOLOGY in the Department of Pathology, and LABORATORY TECHNICIANS for (*a*) the Department of Physiology (for biochemistry), and (*b*) the Division of Histology and Embryology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

CHEMIST to take charge of the research work (at present being carried out at Leeds University)—The Secretary, British Brush Manufacturers' Research Association, 80 Coleman Street, London, E.C.2.

TECHNICIANS (2, Grade III) IN THE DEPARTMENT OF BOTANY—The Secretary, University College, Gower Street, London, W.C.1, quoting Botany/1.

SENIOR LECTURER IN AGRICULTURE responsible for Extra-mural Teaching—The Principal, Kent Farm Institute, Sittingbourne.

BIOCHEMIST (man or woman) preferably with post-graduate experience in the field of enzymes or tissue-metabolism—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.